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TRANSPORTATION TODAY AND TOMORROW.

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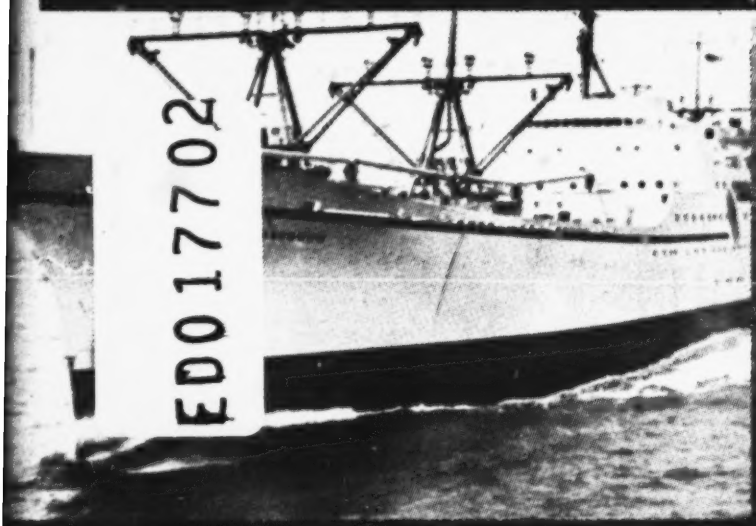

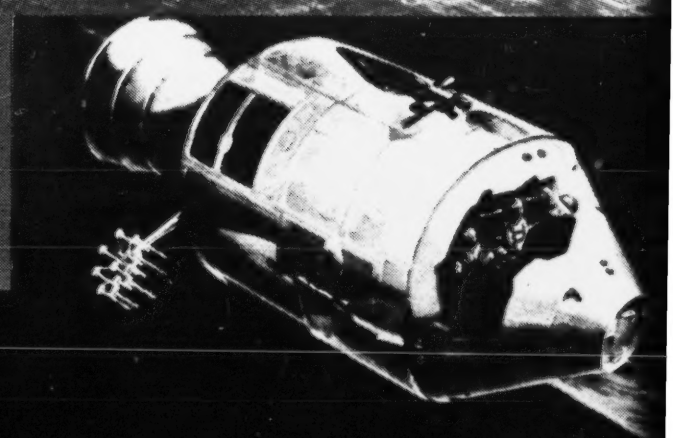

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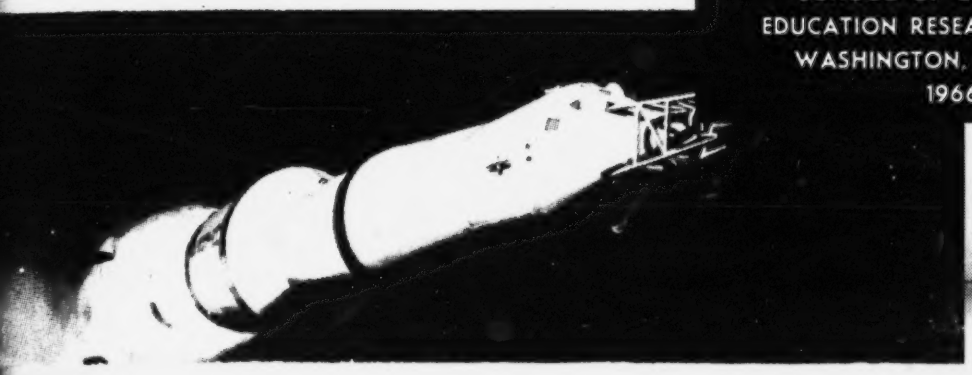

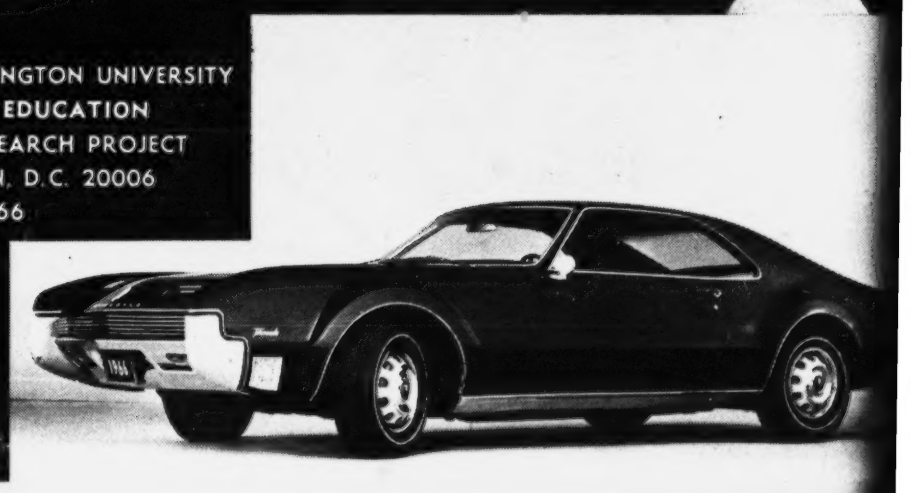

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TRANSPORTATION TODAY AND TOMORROW

THE GEORGE WASHINGTON UNIVERSITY
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Education Research Project
Washington, D.C.

April 1966

This is an experimental booklet intended to help young people learn more about the practical applications of the basic principles of mechanics and technology. It is hoped that students will find the booklet useful and stimulating.

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INTRODUCTION

Transportation means the moving of people and materials from one place to another.

There are many kinds of transportation. People travel in automobiles, buses, trains, and airplanes. Freight is carried by trucks, trains, ships, and airplanes.

We are just beginning to carry people around the earth in rocket-propelled spacecraft. Submarines some day may be used to transport both people and materials. New methods of transportation are being developed all the time.

All means of transportation must be powered in some way. Sometimes gas engines are used, sometimes jet engines. Perhaps in the future many everyday vehicles will have atomic power.

In this booklet you will find out about today's transportation. There are sections on U.S. cars, foreign cars, airplanes and rockets, and the use of atomic power in ships and submarines. Perhaps you will be able to visualize the cars, planes, and spacecraft of the future.

THE 1966 AUTOMOBILES

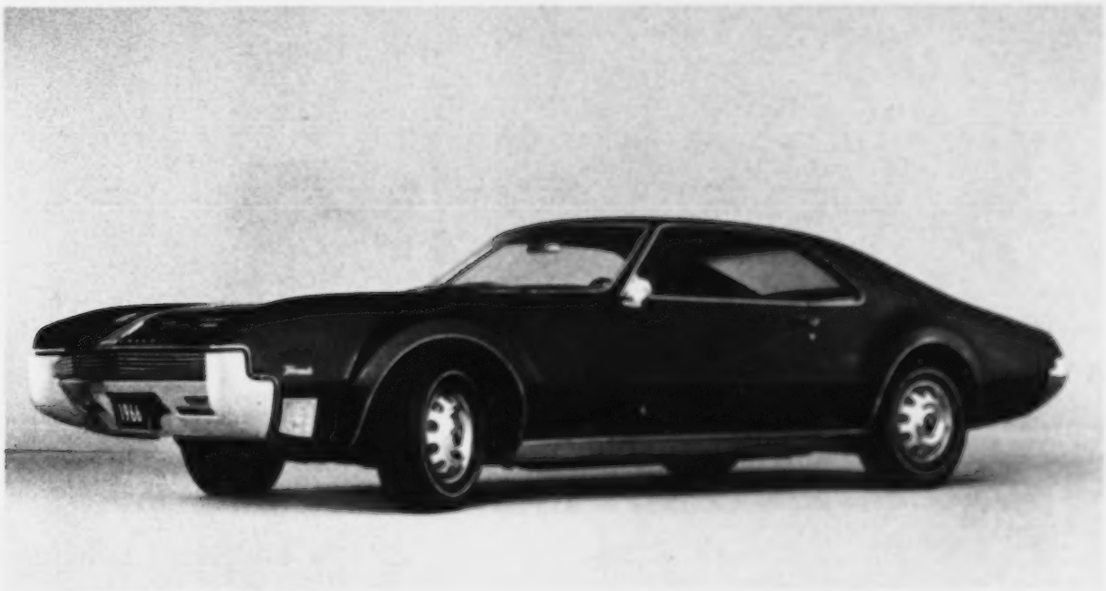
How many passenger car models are offered by United States automobile makers in 1966? Believe it or not, the answer is 364! This is 16 more than in 1965.

The new models have been added by Ford Motor Company and General Motors. Ford has added 8 models and General Motors 17 models.

There are fewer compact cars in 1966 -- only 66 as compared with 86 last year. There is a large increase in the number of intermediate-size cars. There were only 89 intermediates in 1965, while in 1966 there are 118. There are only 7 more regular-size models than in 1965, for a total of 180.

The following pages will tell you about many of the individual 1966 cars.

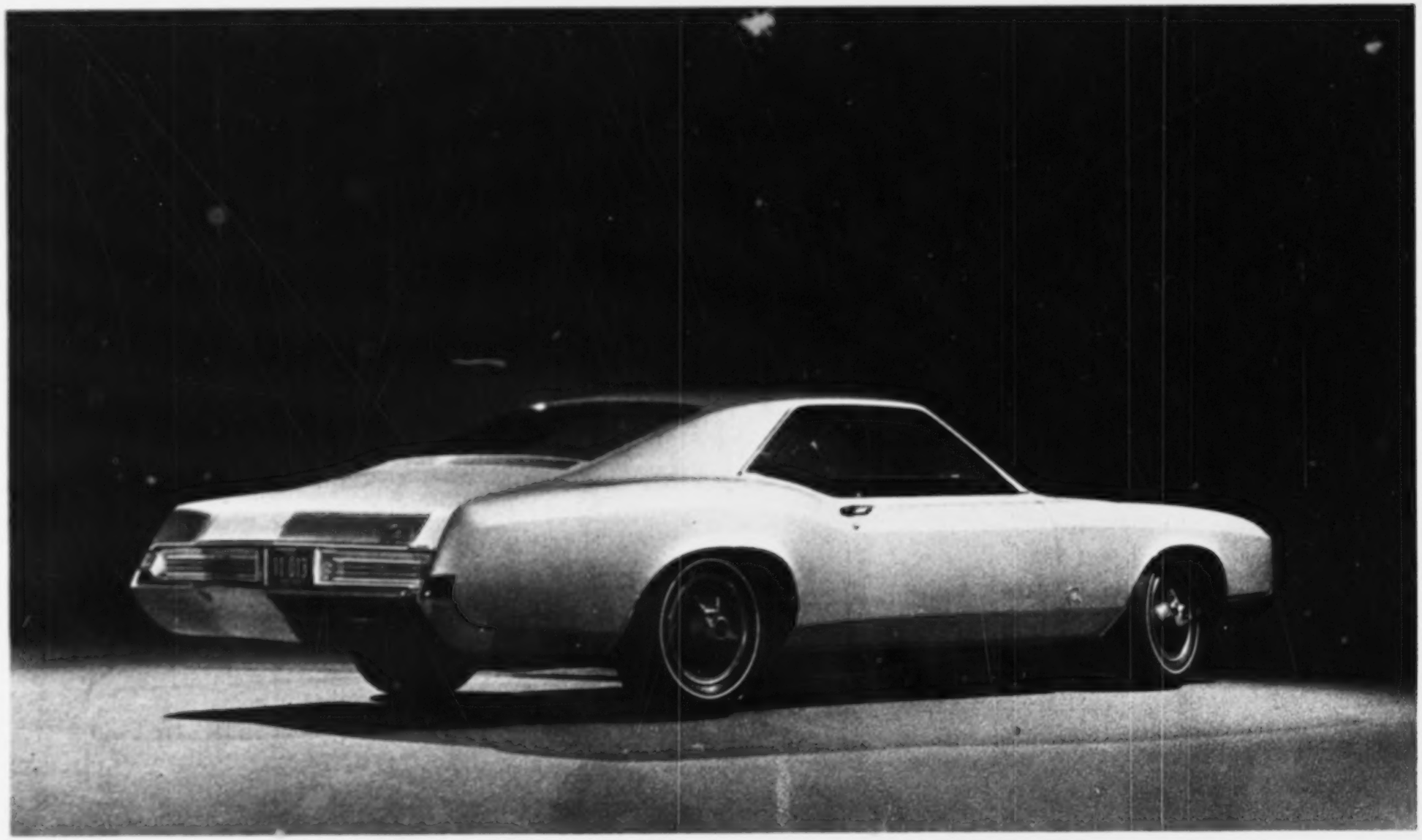
OLDSMOBILE TORONADO



1966 OLDSMOBILE TORONADO

One of the most unusual cars to come out in 1966 is the Oldsmobile Toronado. This car has a front-wheel drive. The engine drives the front wheels instead of the back ones. Driving traction and easy handling are outstanding characteristics of this car. A specially modified 425-cubic-inch Toronado V-8 engine and Turbo Hydra-Matic transmission deliver power to the front wheels. Inside, the Toronado features a flat floor.

For more details about the Toronado, see page 64.



1966 BUICK RIVIERA

BUICK RIVIERA

A completely new Riviera sport coupe features the newest idea in body ventilation in 32 years -- the elimination of window vents. Leaving out these vents gives the driver an unobstructed view through the side window.

A new ventilation system -- called Circulair -- makes the vents unnecessary. Fresh air is taken into the car through a grille in the hood, just in front of the windshield. An outlet at the base of the rear window lets the air out. Elimination of the window vents reduces wind noise in the front compartment.

The new Riviera has a 119-inch wheelbase. It has a 425-cubic-inch V-8 engine.

The Riviera's wider tread improves cornering stability and permits a shorter turn. The longer wheelbase gives greater directional stability and more inside seat room. This wheelbase gives better weight distribution by increasing weight on rear wheels. The increased weight gives better acceleration and braking on ice and snow.

1966 CADILLAC FLEETWOOD BROUGHAM SEDAN

CADILLAC

The 1966 Cadillac is designed for easy driving and riding comfort.

Cadillac's variable-ratio steering gives more driving ease. One-third less turning of the steering wheel is required for parking and driving through traffic.

The Fleetwood Brougham is new in the 1966 Cadillac line. The Fleetwood Seventy-Five sedan and limousine are completely restyled for the first time since 1959.

A completely new automatic dual air-conditioning and heating system for front and rear compartments is now standard on the Seventy-Fives. The system is individually controlled.

Standard safety features are retractable rear seat belts and padded sun visors. A flashing four-way light which acts as a traffic hazard warning system is optional.

The sizes of many models remain the same. The overall length of models ranges from 224 inches to 244.5 inches. The wheelbase of most models is 129.5 inches, but a few models have a larger base.

1966 CHRYSLER IMPERIAL

CHRYSLER IMPERIAL

The 1966 Imperial has a new 440-cubic-inch V-8 engine. The engine can develop up to 350 horsepower. The Imperial can reach 60 miles per hour in under 10 seconds.

The Imperial has a new headlight system which is called "Safety-Sentinel." When another vehicle is 1200 feet ahead of the Imperial, the lights dim.

The Imperial provides a very quiet ride. Improved engine mounts, changes in the drive-line and chassis, and a smoother automatic transmission make the 1966 model even quieter than the models of other years.

This year's Imperial V-8 engine has the largest displacement ever offered by the Chrysler Corporation. Last year's engine had a 413-cubic-inch engine. In 1966 it is 440 cubic inches, with 4.32 in. x 3.75 in. bore and stroke, and a 10.1 to 1 compression ratio.

Other changes this year include increased cooling capacity with a wider radiator core, a fuel induction system made more efficient, and the exhaust system modified to reduce back pressure.

1966 AMBASSADOR DPL

AMERICAN MOTORS AMBASSADOR

American Motors cars have many new features and changes for 1966. There are three new models: DPL, Rebel, and Rogue.

All models have new higher strength laminated safety glass windshields which have two layers of glass bonded to a plastic center.

Six-cylinder engines with manual three-speed transmissions are standard equipment for all four American Motors lines. All of the sixes feature seven-main-bearing crankshafts with eight counter-weights. This arrangement gives smoother operation, high performance, and fuel economy.

A 232-cubic-inch six with two-barrel carburetor, rated at 155 horsepower, is standard on Ambassadors.

Ambassador's optional V-8's are rated at 198, 250, and 270 horsepower. Both the 250- and 270-horsepower V-8's have a displacement of 327 cubic inches. Displacement means the amount of space in the cylinders. The 250 uses regular fuel, but the 270 needs premium fuel.

1966 PONTIAC GTO

PONTIAC GTO

The Pontiac Tempest line includes a new GTO series for 1966. The series includes a sports coupe, hardtop coupe, and convertible.

The basic Tempest engine is a new overhead camshaft type. This type of engine allows easier servicing. The most important feature of the engine's design is the neoprene timing belt reinforced with fiberglas cords, which drives the overhead camshaft. Neoprene is a type of rubber that is resistant to oil, heat, and light.

The GTO series engine is a 335-horsepower 389-cubic-inch V-8 with a four-barrel carburetor. This engine is also used in some of the larger Catalina and Star Chief models.

As on all Pontiac models, a driver-controlled vacuum door lock system is available. The driver's door lock is the master control for all door locks. When it is pushed in to lock, all other doors lock also. When it is raised to unlock, all other doors unlock. Other doors may be locked or unlocked by hand.

Note: GTO means Gran Turismo Omologato. This is an Italian phrase meaning "large touring automobile."

1966 CHEVROLET CAPRICE CUSTOM WAGON

CHEVROLETS

Variety and safety mark the 1966 Chevrolets.

A Caprice luxury series and Super Sport series are added to the regular Chevrolets. A four-door hardtop joins the Chevelle line.

Many safety features are made standard on all models, ranging from padded instrument panels to rear seat belts.

New engines include a 250-cubic-inch six-cylinder and two 427-cubic-inch V-8's. A new three-speed transmission is standard on all models.

New options include a single-dial automatic heating and air-conditioning system and a tilt-telescoping steering column.

Improvements have been made in both chassis and body. Wheelbases of the various lines have been kept unchanged.

Performance of the basic six-cylinder engine is improved by increasing displacement from 230 to 250 inches. There are six V-8's. Horsepower ranges from 155 to 425.

1966 PLYMOUTH BARRACUDA

PLYMOUTH BARRACUDA

The Plymouth Barracuda, a compact sports car, has new design features and a wide range of performance equipment for 1966. Performance equipment is equipment to make the car run better.

There are new fender-mounted turn signals and new shell-type bucket seats.

An option is something extra which can be added to the car if the buyer wants it. Plymouth Barracuda's performance equipment options include front-wheel disk brakes, with or without a power booster; fast ratio manual steering and the Formula S package, consisting of the Commando 273 V-8 engine with a four-barrel carburetor, a heavy-duty suspension system, tachometer, and heavy-gauge wide-rim 14-inch wheels with Blue Streak competition tires.

Cars equipped with the four-speed manual transmission have a new shift lever mechanism which provides rapid, easy shifting into all forward speeds. There is a positive reverse lockout feature to guard against accidental shifting into reverse.

1966 DODGE DART

DODGE DART

The 1966 Dodge Dart has new styling and new inside features. Engineering improvements will provide longer trouble-free motoring and greater ease of operation.

The Dart GT features new front bucket seats and an optional between-seats console. The console houses the gear selector.

Standard engines in the Dart line are a 170-cubic-inch six-cylinder with 101 horsepower and a 273-cubic-inch V-8 with 180 h.p. Optional power plants include the four-barrel-carburetor version of the 273 V-8 called the Charger with 235 h.p.

Three transmissions are offered: three-speed manual, four-speed manual, and three-speed automatic. The four-speed manual has a new shift lever mechanism that provides rapid, easy shifting into all forward speeds. There is a lockout device which prevents accidental shifts into reverse.

Power steering has been improved to give the driver greater help when parking. At low engine speeds, the power boost is increased 30 percent.

1966 FORD FALCON

FORD FALCON

The 1966 Ford Falcon has combined features of both the Mustang and the Falcon.

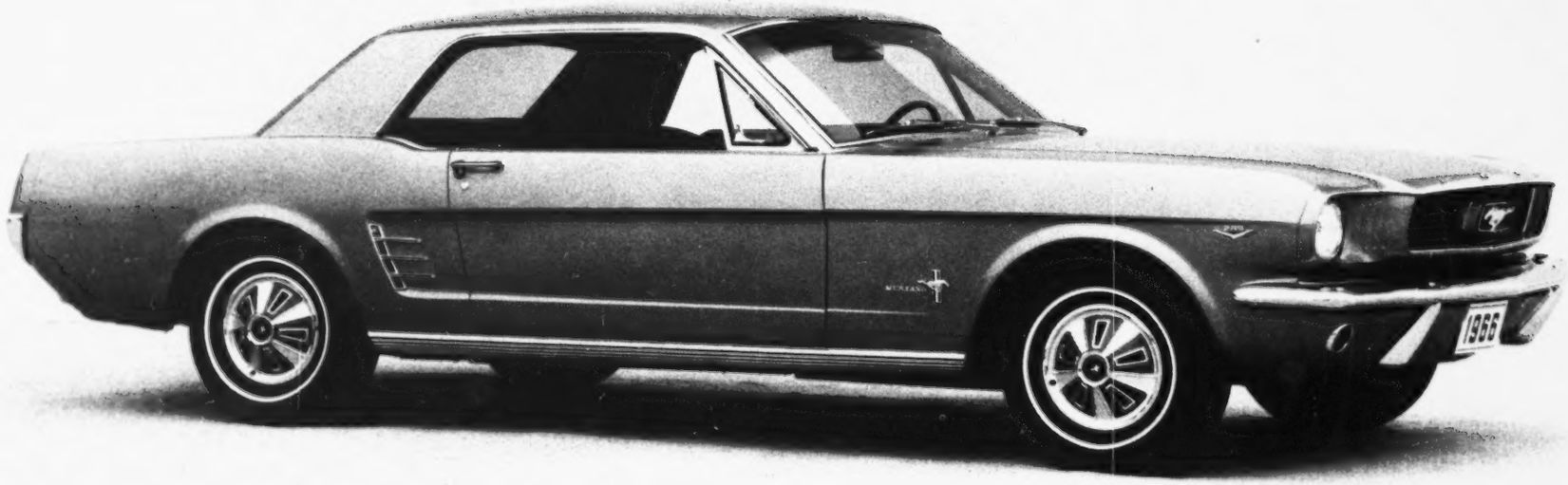
Mustang touches found in the 1966 Falcon are the long hood, short rear deck, rear quarter "hop-up," and round wheel openings.

The wheelbase for sedan models has been increased 1.5 inches to 110.9. Over-all sedan length has been increased 2.7 inches to 184.3. Station wagons are 198.7 inches long, an increase of 14.4. The wheelbase is 113 inches, an increase of 3.5.

The front torque boxes are set apart to keep vibrations from the passenger compartment and provide a rigid structure.

The standard engine for all Falcon models except the Futura Sports Coupe and station wagons is the 170-CID Six. The 200-CID Six engine is standard on the Futura Sports Coupe and station wagons.

Vacuum-assisted power brakes, an option on the Falcon, reduce braking effort by 55 percent. They permit the brake pedal to be positioned low for quick response.



1966 FORD MUSTANG

FORD MUSTANG

New sports and luxury features have been added to this year's Ford Mustang.

A new, five-dial instrument cluster and added safety features are standard on all 1966 Mustangs. New Mustang options include a Stereosonic tape player and a high-performance engine and automatic transmission combination.

In view of the Mustang's award-winning design, outside styling changes in the 1966 Mustang are limited to the grille, side scoop ornament, wheel-covers, and gas filler cap.

The Mustang lineup for 1966 again offers the hard-top, the convertible, and the Mustang 2-plus-2.

The power team lineup introduced a year ago is continued. The lively 200-cubic-inch displacement six-cylinder engine is standard on all models. A three-speed manual transmission is standard.

Mustang's Stereophonic tape system is combined with an AM radio. The cartridge slips into a slot above the radio dial.

1966 LINCOLN CONTINENTAL

LINCOLN CONTINENTAL

The Lincoln Continental of 1966 has added several new features. Its body is longer, its hood more tapering, and its side panels have a less rounded appearance. Its taillights are framed in bumper panels.

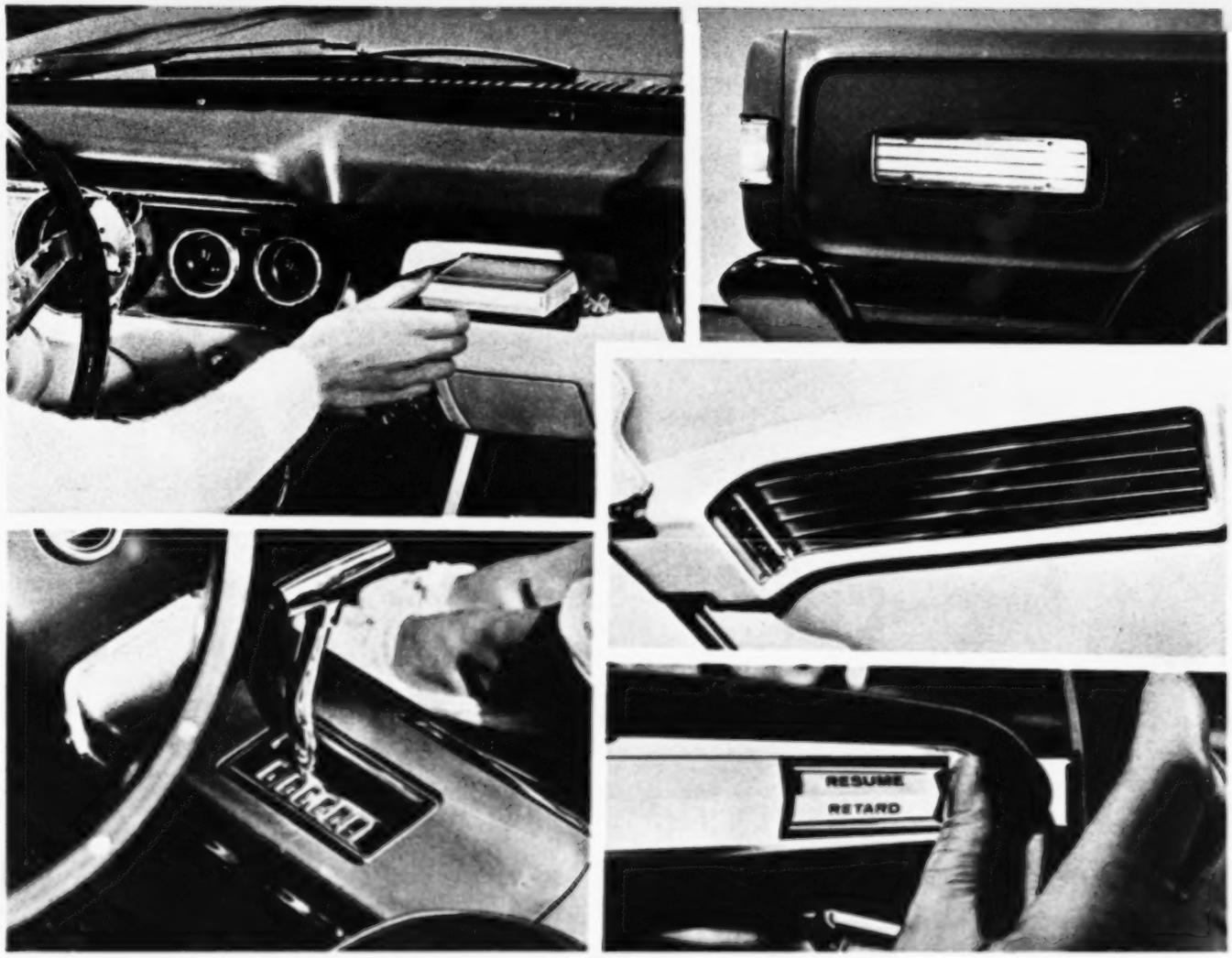
There are now three models of the Continental. The new one this year is a two-door hardtop coupe.

The new Continental has an over-all length of 221 inches, almost 5 inches more than in 1965. It has an additional 2.5 cubic feet of luggage space, although its wheelbase is the same at 126 inches.

The Continental has the largest passenger car engine displacement in production in the automobile industry -- 462 cubic inches. There is a new three-speed torque converter automatic transmission, a new driveshaft, and a new rear axle.

The new instrument control console places everything at the driver's fingertips.

Such options as stereo tape player, 9-inch TV, and automatic temperature-control heater and air conditioner are available.



1966 FORD FEATURES

Ford Motor Company offers many advanced features in the 1966 models. The ones shown above are:

Top left - Stereosonic tape player

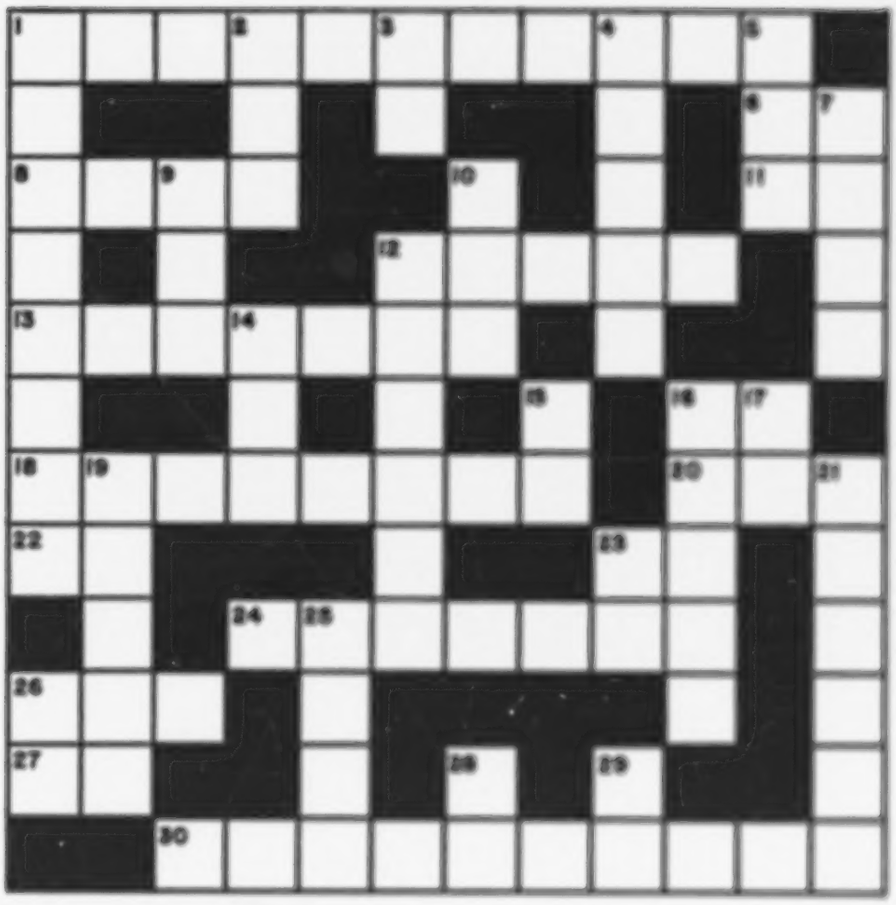
Bottom left - Comet and Fairlane Sportshift

Top right - Mercury optional cornering light

Center right - Thunderbird overhead safety panel

Bottom right - Thunderbird Highway Pilot

PUZZLE 1. AUTOMOBILES



ACROSS

1. One of the Lincoln models.
6. How many_____these cars do you know?
8. The new Dodge_____.
11. Traffic lights tell us when to stop and_____.
12. "Wouldn't you really rather have a_____this year?"
13. The_____Continental.
16. _____you know how to drive a car?
18. The maker of Rambler cars.
20. A car has_____ignition switch. (number)
22. The Ford Motor_____. (abbreviation)
23. An_____in the newspaper helped sell the car.
24. The new Ford car named for a wild horse.
26. The convertible car has a_____ that folds back.
27. Initials for Rolls-Royce.
30. The Toronado, F-85, or Starfire.

DOWN

1. Well-known luxury car.
2. An explosive.
3. Opposite of yes.
4. A strong motor vehicle used to haul heavy articles.
5. Timber sometimes used next to highways as a guard rail.
7. A Model T_____.
9. The car stopped because the battery _____down.
10. _____glasses.
12. The police set up road_____ to check the cars.
14. Another word for automobile.
15. The key was_____the car.
16. "Join the_____Rebellion."
17. Turn the ignition switch_____to start the car.
19. Another word for engine.
21. The cylinders are in the_____.
23. A Model T Ford is_____old or antique car.
25. When you buy a car that is not new it is called a_____car.
26. The Triumph car is sometimes called a_____.
28. The company making Chevrolets. (initials)
29. The air pressure in tires is measured by the_____. (abbreviation)

(Answer on page 119)

1966 DODGE TRUCKS

DODGE TRUCKS

Dodge trucks have been very popular during the past five years. One reason is because changes are made throughout the year instead of waiting for new model introductions.

A new close-ratio, four-speed manual transmission for light-duty trucks was added, permitting higher speed in the first three gears at a given engine speed. The new four-speed transmission, which offers more efficient and economical operation, has a 4.56 ratio in first gear, 2.28 in second, 1.31 in third, and 5.64 in reverse.

The standard four-speed transmission has ratios of 6.68 in first gear, 3.34 in second, 1.66 in third, and 8.26 in reverse.

A 413-cubic-inch V-8 engine is planned for certain medium-duty models this fall. The engine develops 217 gross horsepower at 3,600 r.p.m. and 373 foot-pounds of torque or driveshaft turning power at 2,000 r.p.m.

During the year, Dodge added a 273-cubic-inch 174-horsepower V-8 in the compact line and two V-8 diesels.

1966 CHEVROLET TRUCKS

CHEVROLET TRUCKS

There are several improvements in the 1966 Chevrolet truck line. These include six new engines and an optional three-speed automatic transmission. A new three-ton series has payload capacity up to 34,000 lbs. There are additions of several safety items as standard equipment. Heavy-duty cabs are designed to work better.

The six new engines bring to 25 the number of different power plants offered -- 17 gasoline and 8 diesel. Gas engines new to the 1966 Chevrolet truck line are a 250-cu.-in. six of 155 h.p., a 366-cu.-in. V-8 of 220 h.p., 396-cu.-in. V-8 with 325 and 360 h.p., and two V-6's of 401 and 478 cu. in. with 237 and 254 h.p.

The new diesel is a 637-cu.-in. four-cycle V-8 in two styles with 195 and 220 h.p. It is offered in two models of a new heavy-duty truck.

The 250-cu.-in. six is based on the design of the Chevrolet 230-cu.-in. six, which is kept for some light-duty models. The new engine is much smoother and quieter than previous in-line series. The 366-cu.-in. V-8 engine emphasizes a strong, rigid structure. The engine block is much heavier than ever before.

PONTIAC TEMPEST

: New manual transmission for smoother shifting

OLDSMOBILE CUTLASS

4-Door Holiday Sedan

PONTIAC BONNEVILLE

124-in. wheelbase; 256 - 338 h.p.

CHEVROLET SPORTVAN

6-cylinder engine; 120 - 140 h.p.

AMERICAN MOTORS RAMBLER REBEL

A new addition to the Rambler Classic line

AMERICAN MOTORS MARLIN

145 h.p.; 232-cubic-inch 6-cylinder engine

DODGE CORONET

Redesigned power steering

CHRYSLER 300

A completely new appearance for the 300

CHEVY II

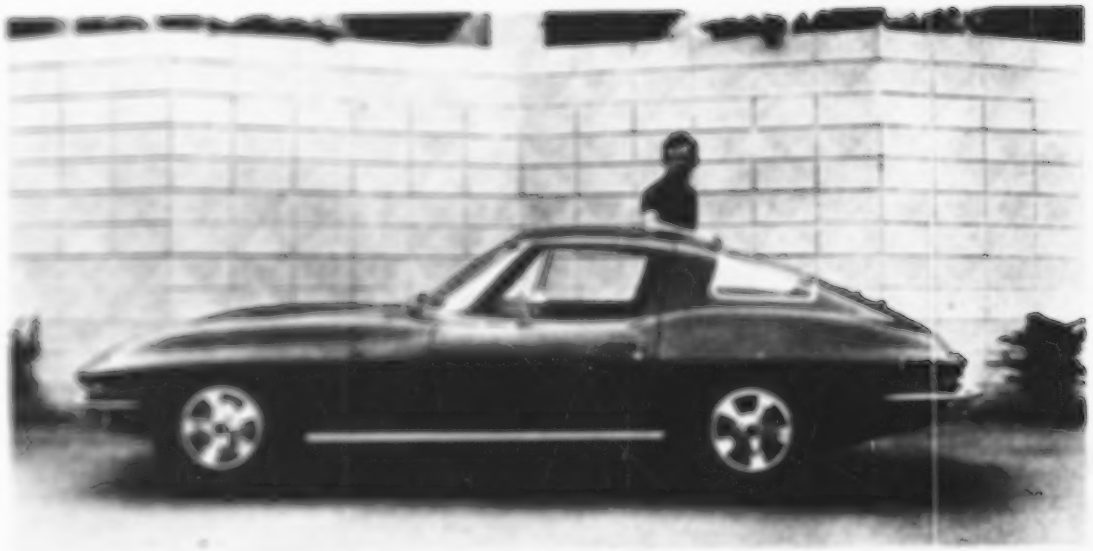
90 to 350 h.p. Wheelbase 110 in.

CORVAIR

95 to 140 h.p. Wheelbase 108 in.

CHEVELLE

120 to 360 h.p. Wheelbase 115 in.



CORVETTE

155 to 425 h.p. Wheelbase 119 in.

BUICK SPECIAL

Improved V-6 engine with two-barrel carburetor

BUICK WILDCAT

126-inch wheelbase 425-cubic-inch V-8 engine

MERCURY

New 410-cubic-inch engine

COMET

Two-inch increase in wheelbase, now 116 inches

PONTIAC LE MANS SPORTS COUPE

New overhead cam six-cylinder engine

PONTIAC GRAND PRIX SPORTSCAR

Four-barrel carburetor and manual transmission

PONTIAC STAR CHIEF EXECUTIVE

The Star Chief is now called the Star Chief Executive

PONTIAC 2 PLUS 2

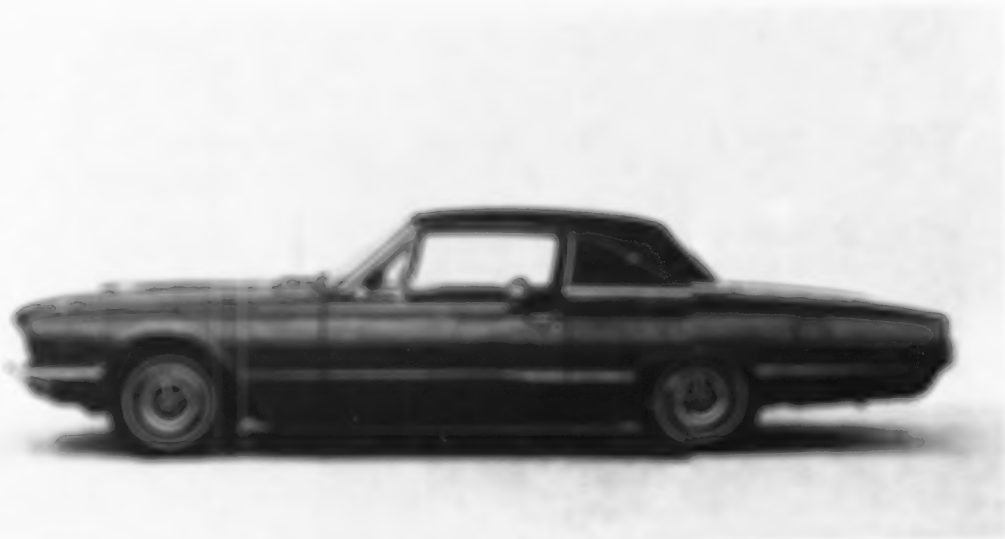
The 2 Plus 2 becomes a separate series in 1966

FORD FAIRLANE

Completely re-engineered

PLYMOUTH VALIANT (SIGNET 2-DOOR HARDTOP)

106-in. wheelbase; 101 to 235 h.p.



THUNDERBIRD

113-inch wheelbase; 315 h.p.

PLYMOUTH BELVEDERE

Optional 426-cubic-in. engine

SPECIFICATIONS -- U.S. CARS -- 1966

	Length	Wheel-base	Tire Size	Curb Weight	Horsepower @ RPM	Displace-ment	Bore and Stroke	Compression Ratio	Carburetion
BUICK									
Special	204.0	115.0	7.35 x 14	3137	160 @ 4200	225	3.75 x 3.40	9.0	1 2-BBL
LeSabre	217.0	123.0	8.15 x 15	4027	220 @ 4000	340	3.75 x 3.85	9.1	1 2-BBL
Wildcat	220.1	126.0	8.45 x 15	4340	325 @ 4400	401	4.1875 x 3.64	10.25	1 4-BBL
Electra 225	223.5	126.0	8.05 x 15	4519	325 @ 4400	401	4.1875 x 3.64	10.25	1 4-BBL
Riviera	211.2	119.0	8.45 x 15	4316	340 @ 4400	425	4.3125 x 3.64	10.25	1 4-BBL
CADILLAC									
Fleetwood 60 SPL.	227.5	133.0	8.00 x 15	4004	340 @ 4600	429	4.13 x 4.00	10.5	1 4-BBL
CHEVROLET									
Corvair	183.3	108.0	6.50 x 13	2530	95 @ 3600	164	3.4375 x 2.94	8.25	2 1-BBL
Chevy II (6)	183.0	110.0	6.95 x 14	2655	120 @ 4400	194	3.563 x 3.25	8.5	1 1-BBL
Chevelle	197.0	115.0	6.95 x 14	3250	120 @ 4400	194	3.563 x 3.25	8.5	1 1-BBL
Chevrolet	213.2	119.0	8.55 x 14	3745	155 @ 4800	250	3.875 x 3.53	8.5	1 1-BBL
Corvette (coupe)	175.1	98.0	7.75 x 15	3160	300 @ 5000	327	4.00 x 3.25	10.5	1 4-BBL
CHRYSLER									
Newport	219.0	124.0	8.25 x 14	4010	270 @ 4400	383	4.25 x 3.38	9.2	1 2-BBL
New Yorker	219.0	124.0	8.25 x 14	4101	340 @ 4600	440	4.32 x 3.75	10.1	1 4-BBL
Chrysler 300	221.9	124.0	8.55 x 14	4228	325 @ 4600	383	4.25 x 3.38	10.0	1 4-BBL
Imperial	227.8	129.0	9.15 x 15	5155	350 @ 4400	440	4.32 x 3.75	10.1	1 4-BBL
DODGE									
Dart	196.3	111.0	6.50 x 13	2761	101 @ 4400	170	3.40 x 3.125	8.5	1 1-BBL
Coronet	203.0	117.0	7.35 x 14	3267	145 @ 4000	225	3.40 x 4.125	8.4	1 1-BBL
Polara	213.3	121.0	8.25 x 14	3991	270 @ 4400	383	4.25 x 3.38	9.2	1 2-BBL
Monaco	213.3	121.0	8.25 x 14	4051	325 @ 4600	383	4.25 x 3.38	10.0	1 4-BBL
FORD									
Falcon	184.3	110.9	6.00 x 14	2560	105 @ 4400	170	3.50 x 2.94	9.1	1 1-BBL
Fairlane	197.0	116.0	6.95 x 14	3080	120 @ 4400	200	3.68 x 3.13	9.2	1 1-BBL
Galaxie 240	210.0	119.0	7.35 x 15	3569	150 @ 4000	240	4.00 x 3.18	9.2	1 1-BBL
Mustang (coupe)	181.6	108.0	6.50 x 13	2556	120 @ 4400	200	3.68 x 3.13	9.2	1 1-BBL
Thunderbird	205.4	113.0	8.15 x 15	4590	315 @ 4600	390	4.05 x 3.78	10.5	1 4-BBL
Bronco	152.1	92.0	7.35 x 15	3107	105 @ 4400	170	3.50 x 2.94	9.1	1 1-BBL

SPECIFICATIONS -- U.S. CARS -- 1966 (Continued)

	Length	Wheel-base	Tire Size	Curb Weight	Horsepower @ RPM	Displace-ment	Bore and Stroke	Compression Ratio	Carburetion
LINCOLN									
Continental	220.9	126.0	9.15 x 15	5344	340 @ 4600	462	4.38 x 3.83	10.25	1 4-BBL
MERCURY									
Comet	203.0	116.0	6.95 x 14	2973	120 @ 4400	200	3.68 x 3.13	9.2	1 1-BBL
Monterey	220.4	123.0	8.15 x 15	4041	265 @ 4400	390	4.05 x 3.78	9.5	1 2-BBL
OLDSMOBILE									
F-85	204.2	115.0	7.35 x 14	3369	155 @ 4200	250	3.875 x 3.53	8.5	1 1-BBL
Jetstar 88	217.0	123.0	7.75 x 14	3965	260 @ 4800	330	3.937 x 3.385	10.25	1 2-BBL
Dynamic 88	217.0	123.0	8.25 x 14	4121	300 @ 4400	425	4.125 x 3.975	9.0	1 2-BBL
Delta 88	217.0	123.0	8.25 x 14	4154	300 @ 4400	425	4.125 x 3.975	9.0	1 2-BBL
Toronado	211.0	119.0	8.85 x 15	4496	385 @ 4800	425	4.125 x 3.975	10.5	1 4-BBL
Starfire (coupe)	217.0	123.0	8.25 x 14	4204	375 @ 4800	425	4.125 x 3.975	10.5	1 4-BBL
Oldsmobile 98	222.9	126.0	8.55 x 14	4368	365 @ 4800	425	4.125 x 3.975	10.25	1 4-BBL
PLYMOUTH									
Valiant	188.3	106.0	6.50 x 13	2888	101 @ 4400	170	3.40 x 3.125	8.5	1 1-BBL
Barracuda (coupe)	188.3	106.0	7.00 x 13	3034	145 @ 4000	225	3.40 x 4.125	8.4	1 1-BBL
Belvedere (8)	200.5	116.0	7.35 x 14	3375	180 @ 4200	273	3.63 x 3.31	8.8	1 1-BBL
Fury	209.8	119.0	7.75 x 14	3781	145 @ 4000	225	3.40 x 4.125	8.4	1 1-BBL
PONTIAC									
Tempest	206.4	115.0	6.95 x 14	3178	165 @ 4700	230	3.875 x 3.25	9.0	1 1-BBL
Catalina	214.8	121.0	8.25 x 14	3973	256 @ 4600	389	4.06 x 3.75	8.6	1 2-BBL
Star Chief	221.8	124.0	8.25 x 14	4059	256 @ 4600	389	4.06 x 3.75	8.6	1 2-BBL
Bonneville	221.8	124.0	8.25 x 14	4194	333 @ 5000	389	4.06 x 3.75	10.5	1 4-BBL
Grand Prix	214.8	121.0	8.25 x 14	4110	333 @ 5000	389	4.06 x 3.75	10.5	1 4-BBL
2 + 2	214.8	121.0	8.25 x 14	4110	338 @ 4600	421	4.09 x 4.00	10.5	1 4-BBL
RAMBLER									
American	181.0	106.0	6.45 x 14	2600	128 @ 4400	199	3.75 x 3.00	8.5	1 1-BBL
Classic	195.0	112.0	6.95 x 14	2900	145 @ 4300	232	3.75 x 3.50	8.5	1 1-BBL
Ambassador	200.0	116.0	7.35 x 14	3000	155 @ 4400	232	3.75 x 3.50	8.5	1 2-BBL

NOTE: These data applied at the beginning of the model year. Certain innovations may have been made at a later date.

ROLLS-ROYCE

The Rolls-Royce originated in England when Frederick Henry Royce decided to build an experimental car of his own design. Royce owned a French car which he used as a starting point. He greatly improved this car by designing his own carburetor, ignition system, clutch, and three-speed gearbox. He made many of the parts himself.

The Royce car had a two-cylinder engine of 10 horsepower. Royce first tested the car on the road in 1904 and made a nonstop trip of 15 miles.

Charles Rolls was the founder of the C.S. Rolls Company. His goal was to sell the best cars available. He heard about the Royce car and went to see it. He liked it so much that he signed an agreement to take all the motor car output of the Royce Company. Since that time these automobiles have been sold under the name Rolls-Royce.

The crankshaft in the early models was made of alloy steel and the valves of high nickel chromium alloy steel. The radiator tank was made of nickel silver. Later models have stainless steel and chrome plating.

The woodwork is made of walnut, and the upholstery is of English leather.

The makers of the Rolls-Royce strive for a dependable car. Speed is not as important as comfort.

Many books have been written about the Rolls-Royce cars. For information on them write to:

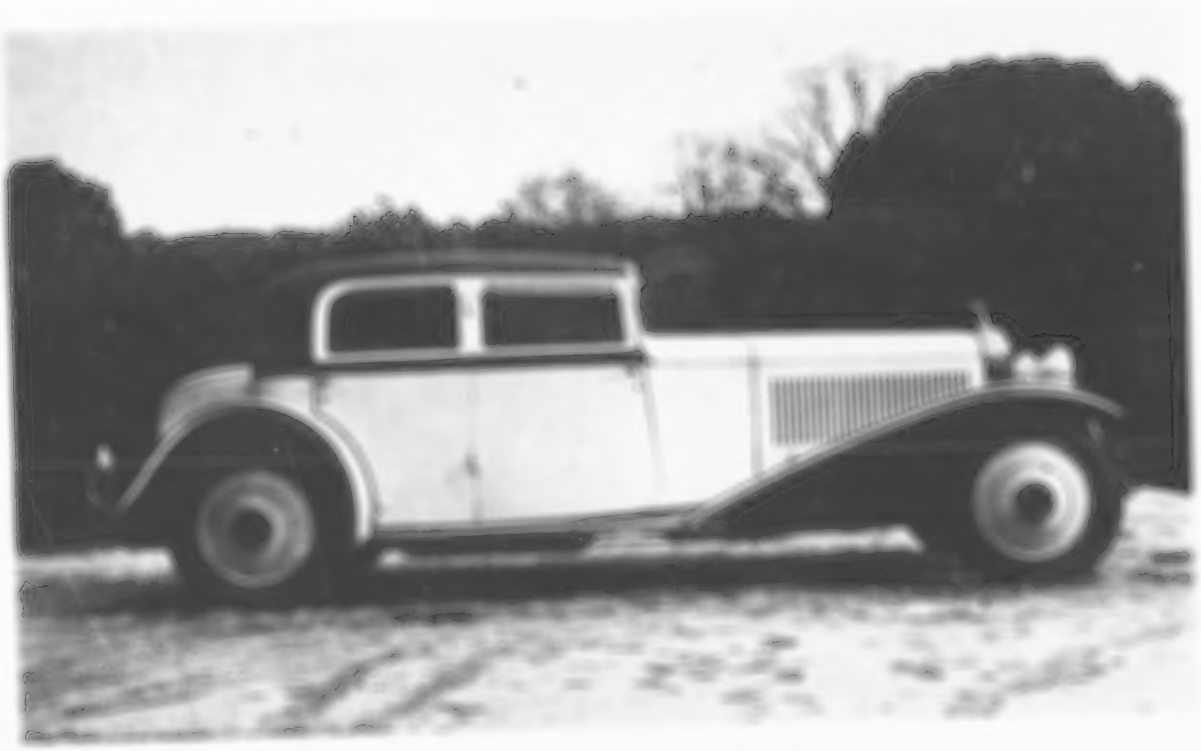
Autobooks
76 Bennett Road
Brighton, Sussex,
England

This company will supply a list of books about the Rolls-Royce. The library may also be able to locate several issues of The Flying Lady, The Periodical of the Rolls-Royce Owners' Club.

ROLLS-ROYCE SILVER SHADOW

The Rolls-Royce Silver Shadow is a completely new model: low and sleek, yet simple. The inside is trimmed with English leather and walnut. The most modern engineering features are used, including disk brakes on all four wheels, unified body-frame construction, and the self-leveling independent four-wheel suspension. The specifications are:

Length	203.5 inches
Wheelbase	119.5 inches
Tire size	8.45 x 15 inches
Curb weight	4636 lbs.
Total capacity	380.5 cu. in.
Bore and stroke	4.100 in. x 3.600 in.
Compression ratio	9:1
Carburetion	4 bbl.



ROLLS-ROYCE PHANTOM II 26EX

This is a picture of the original Phantom II Continental (1930), built to Mr. Royce's specifications for his own use. He sent the Phantom II on a European tour, where it was an instant success. The Phantom II Continental had a low-slung sports-type body.

It could accelerate from rest through the gears to 60 miles per hour in 19.6 seconds. It had a maximum speed of 90 miles per hour in top gear. The typical Rolls-Royce has until recently been a formal-type car meant for chauffeur drive. The 26EX was an early experiment in an owner-driven car.

1966 VOLKSWAGEN FASTBACK

The Volkswagen is a German automobile. Often the Volkswagen is known as the "VW."

The Volkswagen automobile has had the same basic body design for many years. Parts for the Volkswagen have always been easy to get because their basic design has stayed the same even though there have been improvements.

The Volkswagen sedan is the standard model. It is known as the "Bug." For 1966, two new body styles were added: the Fastback and the Squareback Sedan.

1966 VOLKSWAGEN SQUAREBACK

The Fastback has self-adjusting front wheel disk brakes. The VW Fastback uses the same basic parts as the "Bug."

The top speed of the Fastback is 84 m.p.h. It has a four-cylinder twin-carburetor engine located in the rear of the car. The Fastback averages 28 miles to a gallon of regular gas. As the engine is air-cooled, there is no radiator in this car, so it uses no antifreeze.

The Squareback Sedan has a squared-off body. Although it looks different, it too is basically a "Bug." Its square-shaped back allows more storage room.

MERCEDES-BENZ 250S

The Mercedes-Benz 250S is the latest product of the world's oldest automotive manufacturer, Daimler-Benz AG, Stuttgart, Germany. It is an elegant and graceful sedan, spacious and comfortable, with lively performance characteristics.

Mercedes-Benz 250S has many safety features. For example, it has fast and fade-free 4-wheel disk brakes. The body is designed to yield to impact from either front or rear. The car doors are designed to stay closed under hard impact. Everything possible inside the car is padded or recessed.

MERCEDES-BENZ 250S

OTHER FOREIGN CARS

There are many other foreign cars with quality, speed, style, and distinction. Many of them are seen in the United States. Below is a list which shows the country where they are made.

ENGLAND

*Aston Martin
Austin
Austin-Healey
Ford
Hillman
Humber
Jaguar
Lotus Elan
MG
Morgan
Morris
Rolls-Royce
Rover
Sunbeam
Triumph

FRANCE

Citroen
Panhard
Peugeot
Renault
Simca

HOLLAND

DAF

GERMANY

Amphicar
BMW
DKW
Ford
Mercedes-Benz
NSU
Opel
Porsche
Volkswagen

ITALY

Alfa Romeo
Ferrari
Fiat
Innocenti
ISO
Krim-Ghia
Lamborghini
Lancia
Maserati
Vallelunga

JAPAN

Datsun
Toyota

SWEDEN

Saab
Volvo

---

*James Bond, in the Ian Fleming stories, drives an Aston Martin.

ROVER 2000

● A four-door sedan of unique exterior and design, Rover 2000 has without doubles, with outside panels, doors and roof on separate assemblies. Features include adjustable steering wheel, disk brakes on all four wheels with rear units mounted inboard, four-speed transmission. Overhead engine has overhead cam, semi-floating rear axle, to plain crowns and six main bearings.

Wheelbase ..... [illegible]	Displacement ..... [illegible]
Weight ..... [illegible]	Cylinders ..... [illegible]
Length ..... [illegible]	Horsepower ..... [illegible]
Height ..... [illegible]	Price ..... [illegible]

DATSUN 410

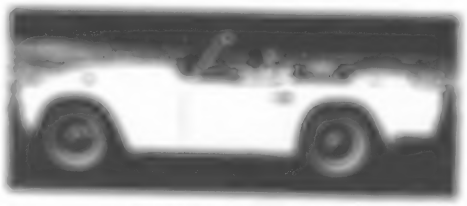
● Datsun 410 sedan features lower center of gravity, unitized body, new doors, bigger windows, alternator, larger brakes, reclining front bucket seats, and padded dash. Standard equipment includes unitized floor heater, safety belts, deluxe wheel covers, outside mirror and backing pre-cup.

Wheelbase ..... [illegible]	Displacement ..... [illegible]
Weight ..... [illegible]	Cylinders ..... [illegible]
Length ..... [illegible]	Horsepower ..... [illegible]
Height ..... [illegible]	Price ..... [illegible]

MG SPORTS SEDAN

● The MG Sports Sedan continues to be one of the most worthwhile of all imports with its Hydrolastic suspension system, transverse-mounted engine and front-wheel drive. This big-inside sedan also offers rubber-mounted body, front-wheel disk brakes and four-speed transmission.

Wheelbase ..... [illegible]	Displacement ..... [illegible]
Weight ..... [illegible]	Cylinders ..... [illegible]
Length ..... [illegible]	Horsepower ..... [illegible]
Height ..... [illegible]	Price ..... [illegible]



TRIUMPH TR-4

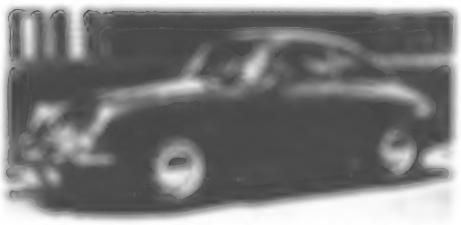
● Long sweep belt in the sideways and on the new track has been enjoyed by the Triumph TR-4. A full list of competition equipment is available for this car, which come equipped with front-disk brakes, four-speed gearbox and twin Stromberg carburetors.

Wheelbase ..... [illegible]	Displacement ..... [illegible]
Weight ..... [illegible]	Cylinders ..... [illegible]
Length ..... [illegible]	Horsepower ..... [illegible]
Height ..... [illegible]	Price ..... [illegible]

SUNBEAM TIGER

● Ford 260-cubic-inch V-8 gives Sunbeam Tiger its class. Performance options can boost top speed to 130 miles per hour. Distinguishing marks are chrome "tiger stripe" on fender and "Powered by Ford" medallions. Features include reclining seats, adjustable steering wheel and sound-proofing.

Wheelbase ..... [illegible]	Displacement ..... [illegible]
Weight ..... [illegible]	Cylinders ..... [illegible]
Length ..... [illegible]	Horsepower ..... [illegible]
Height ..... [illegible]	Price ..... [illegible]



PORSCHE 356-C

● Porsche likes to call its 356-C a competition car that is fun to drive to work. The car is engineered for safety and performance and features include deeper bucket seats, a redesigned instrument panel, the famed Porsche four-speed transmission, disk brakes on all four wheels with rear units incorporating drums for the hand brake, hand-assembled engine and torsion-bar suspension on all four wheels.

Wheelbase ..... [illegible]	Displacement ..... [illegible]
Weight ..... [illegible]	Cylinders ..... [illegible]
Length ..... [illegible]	Horsepower ..... [illegible]
Height ..... [illegible]	Price ..... [illegible]

ENGLISH FORD CORTINA

● Available as a two-door or four-door sedan, the English Ford Cortina Deluxe is a full five-passenger car which uses American-standard nuts and bolts. Engine has five main bearings. Foam padding is used extensively. American-design automatic transmission is available. A high-performance GT version is offered.

Wheelbase ..... [illegible]	Displacement ..... [illegible]
Weight ..... [illegible]	Cylinders ..... [illegible]
Length ..... [illegible]	Horsepower ..... [illegible]
Height ..... [illegible]	Price ..... [illegible]

RENAULT 8-0 1100

● Renault 8-0 1100 is termed a "second-generation" economy car. Features include sealed cooling system, disk brakes on all four wheels with circuitrybe to prevent rear-wheel lockup, four-wheel independent suspension, five-bearing crankshaft, electric windshield wipers and washer, padded dash and visors, fully-automatic transmission model available.

Wheelbase	[illegible]	Displacement	[illegible]
Weight	[illegible]	Cylinders	[illegible]
Length	[illegible]	Horsepower	[illegible]
Height	[illegible]	Price	[illegible]

SIMCA 1000

● Sporting Chrysler Corp.'s Frenchmade economy car, the Simca 1000 is hedging steadily ahead in U. S. consumerdom. Features include rear engine, bucket seats, unitized construction, four-speed transmission, four-wheel independent suspension and five-bearing crankshaft.

Wheelbase	[illegible]	Displacement	[illegible]
Weight	[illegible]	Cylinders	[illegible]
Length	[illegible]	Horsepower	[illegible]
Height	[illegible]	Price	[illegible]

ROLLS-ROYCE SILVER CLOUD III

● Perhaps the one grille that can be instantly recognized the world over is the Rolls-Royce trademark. Interiors, of course, are in the impeccable Rolls tradition. Engineering features include brakes with two independent hydraulic systems, plus mechanical linkage, a V-8 aluminum engine, power steering, four-speed automatic transmission and a body with dressed coat skin.

Wheelbase	[illegible]	Displacement	[illegible]
Weight	[illegible]	Cylinders	[illegible]
Length	[illegible]	Horsepower	[illegible]
Height	[illegible]	Price	[illegible]

VOLVO 122-S

● Volvo 122-S takes on distinctive look for 1969 with dished wheels, stainless steel hubcaps and a new grille. Other features include newly developed front seats with adjustable support built into headrests and improved rear-compartment heating. Automatic transmission is optional. A two-door sedan is available at $2,[illegible].

Wheelbase	[illegible]	Displacement	[illegible]
Weight	[illegible]	Cylinders	[illegible]
Length	[illegible]	Horsepower	[illegible]
Height	[illegible]	Price	[illegible]

SAAB

● Now, held front of Saab enlarged hinged hood and redesigned grille. Increasing hood 2.2 inches provided room for installation of new cooling system with wider air intake for radiator, now mounted in front of the engine. Model with four-speed transmission is available.

Wheelbase	[illegible]	Displacement	[illegible]
Weight	[illegible]	Cylinders	[illegible]
Length	[illegible]	Horsepower	[illegible]
Height	[illegible]	Price	[illegible]

TOYOTA 1900

● Toyota claims most power of any import in its class for the 1900 sedan, which is rated at $3. Features include torsion-bar suspension, electric wipers, backup lights, fawn front seat, padded dash, courtesy lights on all four doors, alternator, carpeting and unitized body.

Wheelbase	[illegible]	Displacement	[illegible]
Weight	[illegible]	Cylinders	[illegible]
Length	[illegible]	Horsepower	[illegible]
Height	[illegible]	Price	[illegible]

VOLKSWAGEN 1200

● How modern can you get with a design that is basically 30 years old? The Volkswagen offers fastback, bucket seats and four on the floor. Other endearing features have long established the beetle as America's best-selling import.

Wheelbase	[illegible]	Displacement	[illegible]
Weight	[illegible]	Cylinders	[illegible]
Length	[illegible]	Horsepower	[illegible]
Height	[illegible]	Price	[illegible]

ALFA ROMEO GIULIA TI

● Alfa Romeo Giulia TI combines speed and economy, comfort and easy handling, high quality and performance. Twin-overhead-cam engine of modest size can move car at over 100 miles per hour. Outstanding features include five-speed transmission, four-wheel disk brakes, unitized construction. Also available as convertible, coupe or GT.

Wheelbase	[illegible]	Displacement	[illegible]
Weight	[illegible]	Cylinders	4
Length	[illegible]	Horsepower	[illegible]
Height	[illegible]	Price	[illegible]

FIAT 1100-D

● Fiat 1100-D four-door sedan has roll-down windows in all doors, reclining bucket seats and a long list of "usual-and" goodies such as light in trunk and engine compartment, whitewalls, outsize rear-view mirror, undercoating, windshield washers, rubber-padded bumper guards and aluminum-finned brake drums.

Wheelbase	[illegible]	Displacement	[illegible]
Weight	[illegible]	Cylinders	4
Length	[illegible]	Horsepower	[illegible]
Height	[illegible]	Price	[illegible]

HILLMAN SUPER MINX

● Restyled for 1965, the Hillman Super Minx sedan now has 20 percent more glass area for better visibility. New interior features include reclining seats and an improved layout for instruments and controls. A station wagon is available at $2,[illegible].

Wheelbase	[illegible]	Displacement	[illegible]
Weight	[illegible]	Cylinders	4
Length	[illegible]	Horsepower	[illegible]
Height	[illegible]	Price	[illegible]

MERCEDES-BENZ 220-S

● One of the products of the world's oldest auto maker, the 220-S version of the Mercedes-Benz offers discreet elegance, excellent finish, solid engineering. A fuel-injection version is available. Disk brakes are used in front. Automatic transmission is optional.

Wheelbase	[illegible]	Displacement	[illegible]
Weight	[illegible]	Cylinders	6
Length	[illegible]	Horsepower	[illegible]
Height	[illegible]	Price	[illegible]

JAGUAR XK-E

● The 1965 Jaguar XK-E sports coupe has the same award-winning exterior lines, but many changes under the hood. A new [illegible]-cubic-inch engine develops [illegible] horsepower and gives the car a top speed of 140 miles per hour. Other changes include improved bucket seats, a fully synchronized four-speed gearbox, alternator and power disk brakes on all wheels.

Wheelbase	[illegible]	Displacement	[illegible]
Weight	[illegible]	Cylinders	6
Length	[illegible]	Horsepower	[illegible]
Height	[illegible]	Price	[illegible]

CITROEN DS-19 PALLAS

● Sumptuous is the word for the Citroen DS-19 Pallas. Interior features a new design treatment of fabrics, leather and padding and optional leather upholstery. Increased amounts of carpeting and insulating materials are used. External changes include stainless body trim and wheel covers and integrated dual fog lamps. Features include air-oil suspension and dual-system disk brakes.

Wheelbase	[illegible]	Displacement	[illegible]
Weight	[illegible]	Cylinders	4
Length	[illegible]	Horsepower	[illegible]
Height	[illegible]	Price	[illegible]

OPEL KADETT

● Opel Kadett has carried General Motors' comeback into the import market with a strong position among the leaders. Front bucket seats tilt for easy passage to rear seat and the sliding sunroof is an added feature. Also available as a sport coupe and station wagon.

Wheelbase	[illegible]	Displacement	[illegible]
Weight	[illegible]	Cylinders	4
Length	[illegible]	Horsepower	[illegible]
Height	[illegible]	Price	[illegible]

AUSTIN-HEALEY 3000

● Luxury touches uncommon in a sports car set the Austin-Healey 3000 apart. Car features carpeted floor, wood-paneled dash, fold-down rear seat, storage locker in console, roll-up windows, adjustable bucket seats. Overdrive, wire wheels, front disks are standard.

Wheelbase	[illegible]	Displacement	[illegible]
Weight	[illegible]	Cylinders	6
Length	[illegible]	Horsepower	[illegible]
Height	[illegible]	Price	[illegible]

PEUGEOT 404

● Crisper lines and more urge distinguish the Peugeot 404 from its running mate, the 403. Extended list of standard equipment, a Peugeot hallmark, extends to the 404, of course.

Wheelbase	[illegible]	Displacement	[illegible]
Weight	[illegible]	Cylinders	4
Length	[illegible]	Horsepower	[illegible]
Height	[illegible]	Price	[illegible]

U.S. CARS - 1965

DODGE CORONET — Wheelbase: 117 inches. Length: 204.2 inches. Horsepower range: 145 to 425. There are 12 models. Prices start at $2,232.

STUDEBAKER—Wheelbase: 109 and 113 inches. Length: 190 and 194 inches. Horsepower range: 120 to 195. There are six models. Prices start at $2,125.

PLYMOUTH BELVEDERE—Wheelbase: 116 inches. Length: 203.4 inches. Horsepower range: 145 to 425. There are 10 models. Prices start at $2,241.

CHEVROLET CHEVY II—Wheelbase: 110 inches. Length: 182.9 inches. Horsepower range: 90 to 300. There are seven models. Prices start at $2,011.

FORD FAIRLANE — Wheelbase: 116 inches. Length: 199 inches. Horsepower range: 120 to 271. There are eight models. Prices start at $2,230.

CHEVROLET CHEVELLE—Wheelbase: 115 inches. Length: 196.6 inches. Horsepower range: 120 to 350. There are 12 models. Prices start at $2,156.

FORD FALCON — Wheelbase: 109.5 inches. Length: 181.6 inches. Horsepower range: 105 to 200. There are 13 models. Prices start at $2,020.

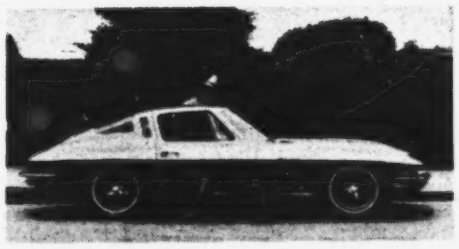
CHECKER — Wheelbase: 120 and 129 inches. Length: 199.5 and 208.3 inches. Horsepower range: 140 to 250. There are three models. Prices start at $2,793.

OLDSMOBILE F-85 — Wheelbase: 115 inches. Length: 204.3 inches. Horsepower range: 155 to 345. There are 13 models. Prices start at $2,344.

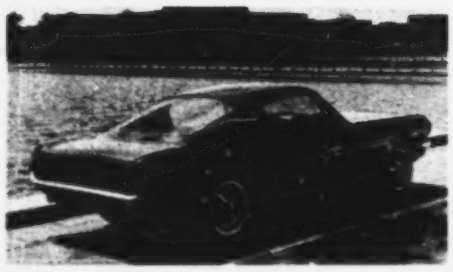
FORD—Wheelbase: 119 inches. Length: 210 inches. Horsepower range: 150 to 425. There are 17 models. Prices start at $2,361.

2

U.S. CARS - 1965 (Continued)



CHEVROLET CORVETTE — Wheelbase: 98 inches. Length: 175.1 inches. Horsepower range: 250 to 425. There are two models. Prices: Coupe, $4,321; convertible, $4,106.



FORD MUSTANG — Wheelbase: 108 inches. Length: 181.6 inches. Horsepower range: 120 to 271. There are three models. Prices start at $2,372.

BUICK RIVIERA—Wheelbase: 117 inches. Length: 208 inches. Horsepower range: 325 to 360. The Riviera, a two-door hardtop, is priced at $4,408.

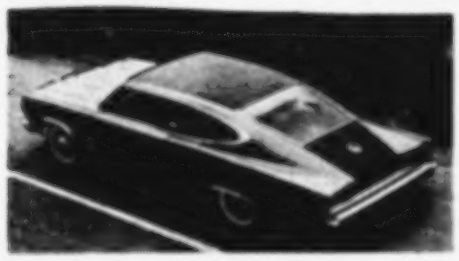
PLYMOUTH BARRACUDA — Wheelbase: 106 inches. Length: 188.2 inches. Horsepower range: 145 to 235. The Barracuda, a two-door hardtop, is priced at $2,502.

FORD THUNDERBIRD—Wheelbase: 113.2 inches. Length: 205.4 inches. Horsepower: 300. There are three models. Prices start at $4,486.

DODGE DART—Wheelbase: 111 inches. Length: 196.4 inches. Horsepower range: 101 to 235. There are 10 models. Prices start at $2,089.

PONTIAC TEMPEST — Wheelbase: 115 inches. Length: 206.1 inches. Horsepower range: 140 to 360. There are 12 models. Prices start at $2,260.

CHEVROLET CORVAIR—Wheelbase: 108 inches. Length: 183.3 inches. Horsepower range: 95 to 180. There are seven models. Prices start at $2,066.

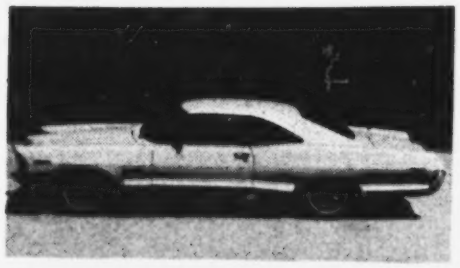


RAMBLER MARLIN — Wheelbase: 112 inches. Length: 195 inches. Horsepower range: 155 to 270. The Marlin, a two-door hardtop, is priced at $2,897.

MERCURY COMET — Wheelbase: 114 inches. Length: 195.3 inches. Horsepower range: 120 to 271. There are 11 models. Prices start at $2,154.

U.S. CARS - 1965 (Continued)

CHRYSLER — Wheelbase: 124 inches. Length: 218.2 inches. Horsepower range: 270 to 360. There are 17 models. Prices start at $3,024.

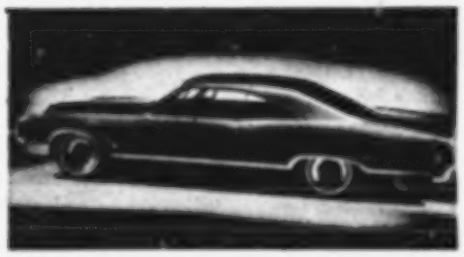


PONTIAC—Wheelbase: 121 and 124 inches. Length: 214.6 and 221.7 inches. Horsepower range: 256 to 376. There are 14 models. Prices start at $2,734.

MERCURY — Wheelbase: 123 inches. Length: 218.4 inches. Horsepower range: 250 to 425. There are 15 models. Prices start at $2,767.

LINCOLN CONTINENTAL — Wheelbase: 126 inches. Length: 216.3 inches. Horsepower: 320. There are two models. Prices: Four-door sedan, $6,292; four-door convertible, $6,938.

CADILLAC—Wheelbase: 129.5 to 149.8 inches. Length: 224 to 243.8 inches. Horsepower: 340. There are 11 models. Prices start at $5,059.



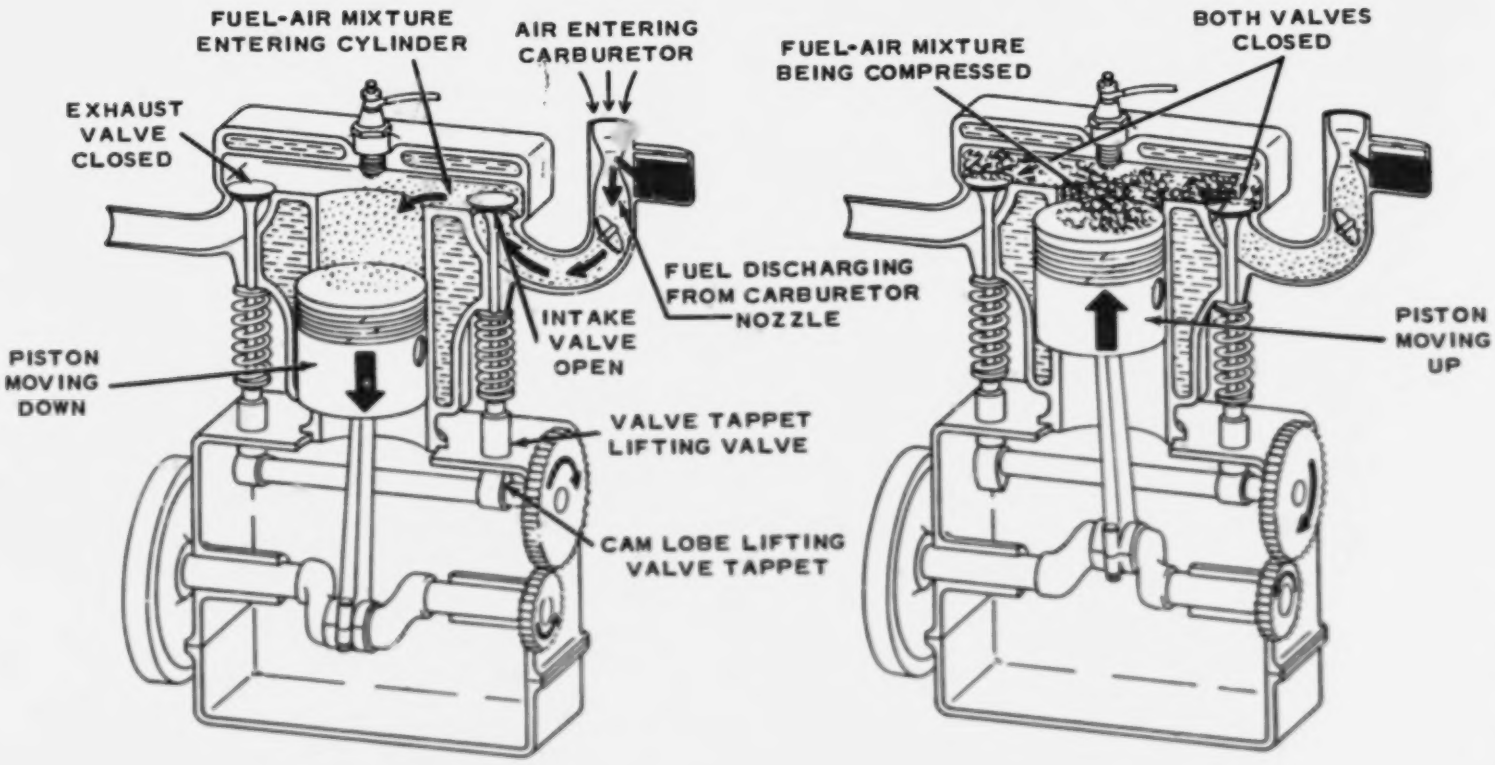
BUICK—Wheelbase: 123 and 126 inches. Length: 216.9 to 222.9 inches. Horsepower range: 210 to 360. There are 24 models. Prices start at $2,948.

IMPERIAL — Wheelbase: 129 inches. Length: 227.8 inches. Horsepower: 340. There are four models. Prices start at $5,795.

OLDSMOBILE—Wheelbase: 123 and 126 inches. Length: 216.9 and 222.9 inches. Horsepower range: 250 to 370. There are 19 models. Prices start at $2,938.

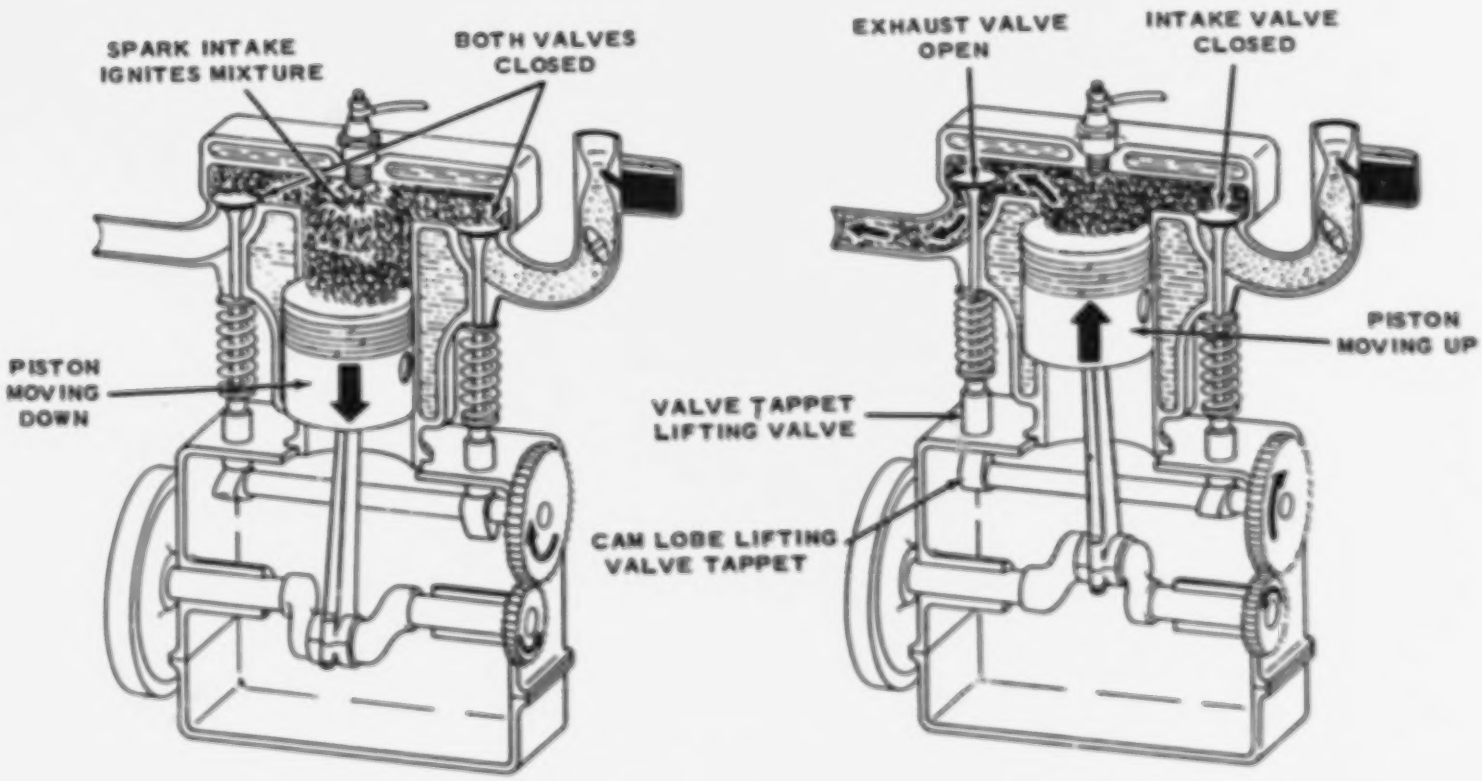
CHEVROLET — Wheelbase: 119 inches. Length: 213.1 inches. Horsepower range: 140 to 425. There are 15 models. Prices start at $2,363.

RAMBLER AMBASSADOR — Wheelbase: 116 inches. Length: 200 inches. Horsepower range: 155 to 270. There are eight models. Prices start at $2,512.



INTAKE

COMPRESSION



POWER

EXHAUST

FOUR-STROKE CYCLE IN A GASOLINE ENGINE

GASOLINE ENGINE

In a gasoline engine the power is supplied by expanding gas pushing against a piston. Gas engines are internal combustion engines. This means the fuel burns inside the engine. Automobiles usually have gas engines.

There are four piston strokes for each fuel explosion in most gas engines. The first stroke is the <u>intake stroke</u>. A valve in the cylinder opens briefly as the piston moves downward. This lets in the fuel mixture.

The second stroke, the <u>compression stroke</u>, compresses or squeezes the mixture into the upper part of the cylinder.

The <u>power stroke</u> is the third stroke. An electric spark is produced at the base of the spark plug. The spark ignites the mixture. The heat of combustion, or burning, makes the gases expand quickly. This expansion pushes the piston down.

The <u>exhaust stroke</u> is the last stroke before the cycle of strokes starts again. As the piston goes up, another valve in the cylinder head opens briefly. The used gas escapes through the manifold and exhaust pipe.

DIESEL ENGINE

Many large machines are powered by diesel engines. Railroad trains, large buses and trucks, bulldozers, and electric power plants all use diesel engines. Some specially designed diesel engines are also used in sports cars.

The diesel engine operates somewhat like the gasoline engine. Air drawn into the cylinders is compressed by the return strokes of the pistons. The temperature of the compressed air rises to about 1,000° F. because it is crammed into about 1/16 of its original space.

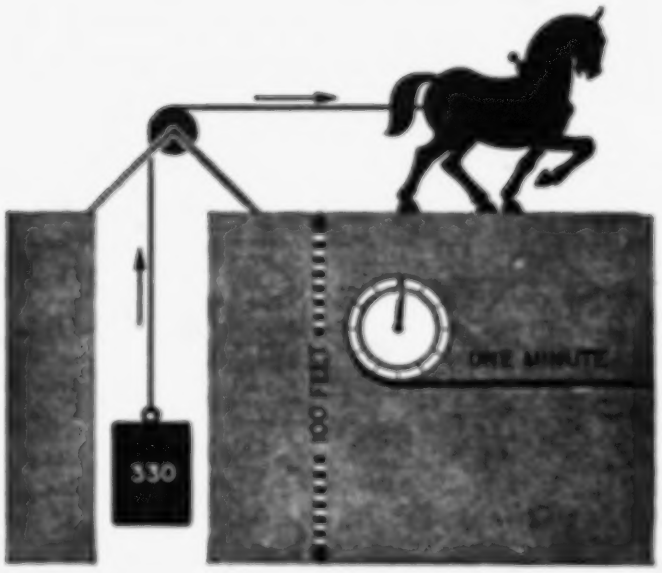
When the fuel oil is sprayed into the cylinder it meets and mixes with this hot compressed air, and ignites. This burning causes the piston to move downward. This turns the crankshaft and supplies power. As the piston rises again, used gases are pushed out of the cylinder.

The diesel engine is an internal combustion engine. It is inexpensive to operate because it burns fuel oil. The diesel engine has a simple design. Its main disadvantage is its size as it is heavy and large in comparison to the power it develops.

HORSEPOWER

The power of an engine can be measured in horsepower. A large new car engine might have 300 to 400 h.p. A small car might have less than 100 h.p. Small outboard motors might have 3 to 10 h.p. Small electric motors often have only a fraction of one horsepower. On the other hand, large rocket engines may have thousands of horsepower!

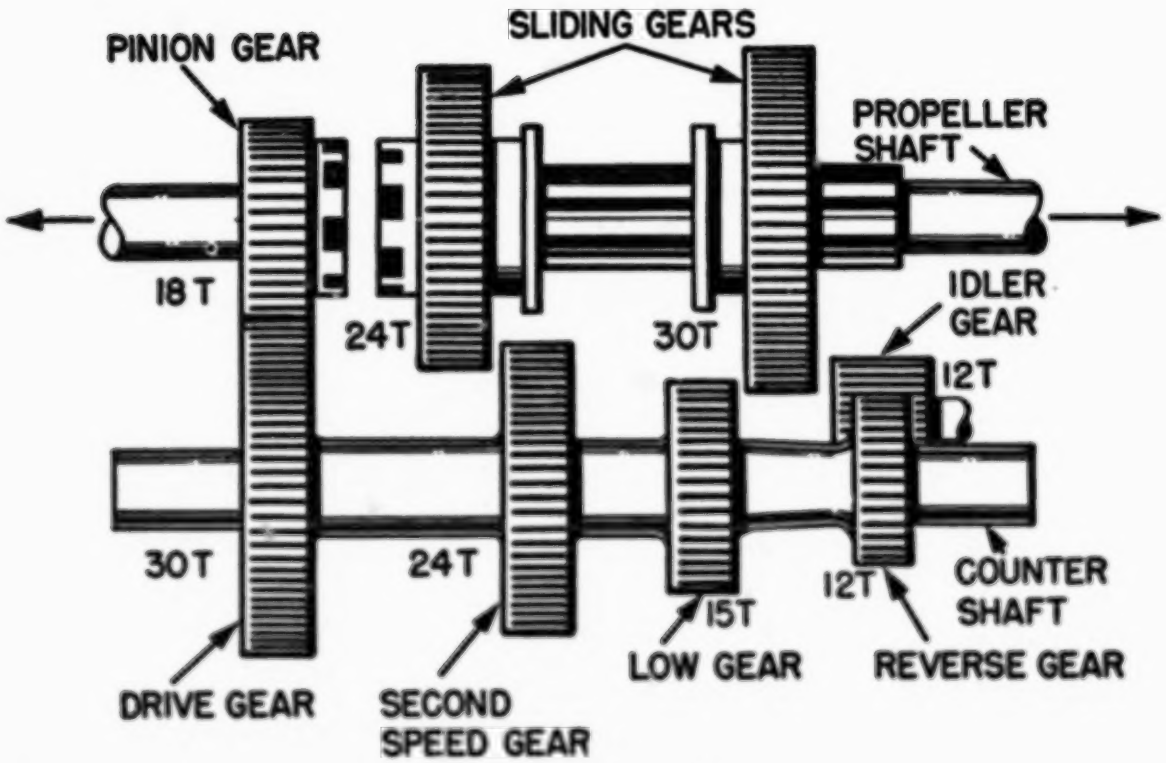
How do we measure horsepower? The picture shows a horse lifting 330 pounds. He lifts it 100 feet in one minute. This amount of power is equal to one horsepower, or one horsepower equals 33,000 pounds lifted one foot in one minute. This is 33,000 foot-pounds of work done in one minute.



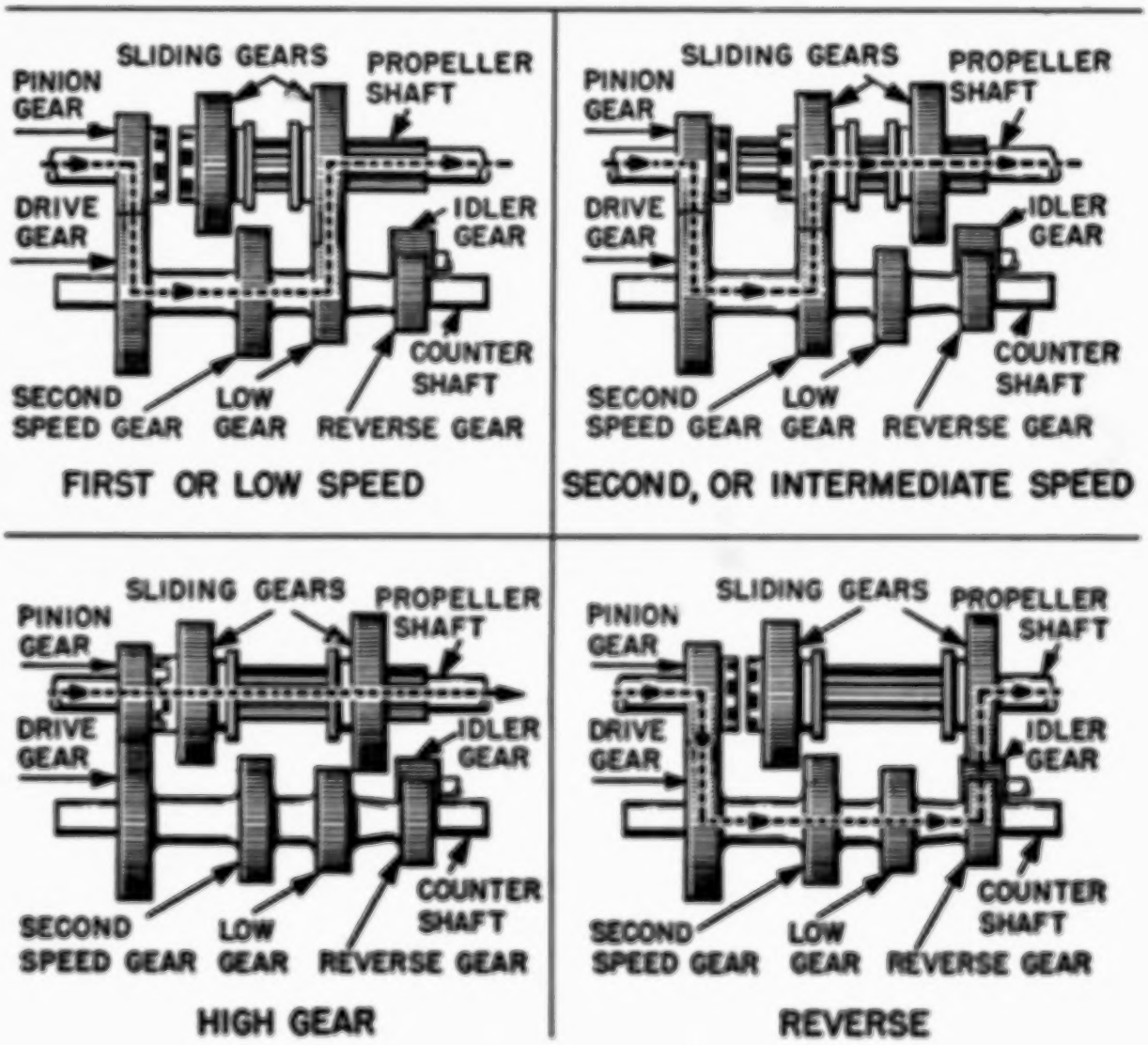
Suppose an engine could lift 33,000 pounds 100 feet in one minute. How many horsepower would that be? It would be 100 horsepower.

What would your own horsepower be if you could lift 66 pounds 100 feet in one minute? You would be doing 6600 foot-pounds of work per minute. It takes 33,000 foot-pounds of work per minute for one horsepower. Your horsepower would be 1/5.

THE GEARSHIFT



GEARS IN NEUTRAL



HOW THE GEARSHIFT WORKS

The transmission makes it possible to change the speed of a car. It also is used to make it go forward or backward. It changes the relationship or ratio between engine speed and wheel speed.

The gearshift in a car is part of the transmission. You probably know that moving the gearshift lever can put a car in low gear or reverse. Often a car will have three different forward speeds.

This figure shows how a typical transmission is arranged. The gears are shown in neutral, first, second, high, and reverse. Look at the diagram for first gear (low speed). The power of the engine goes from the pinion gear to the drive gear on the countershaft. This makes the countershaft and its attached gears turn.

The low gear is fitted into (meshed with) the second sliding gear. The turning of the sliding gear makes the propeller shaft turn with it. The propeller shaft makes the wheels turn.

One of the main parts of the transmission is the sliding gears. The sliding gears may be shifted along

the main shaft. This is what happens when the gearshift lever is moved. The sliding gears are fastened to a grooved shaft. They turn the shaft as they rotate even though they can be shifted back and forth on the shaft. The drive gear and the speed gears are located on the lower or countershaft.

Look at the gear train or power train when in first, or low speed. The pinion gear is smaller than the drive gear it meshes with. This causes a drop in speed and an increase in power. The ratio is 18 teeth to 30 teeth.

The power from the countershaft is transmitted to the sliding gear and the propeller shaft by a smaller gear (low gear). This again lowers speed and raises power. The ratio is 15 teeth to 30 teeth. This is why a car moves slowly but has a lot of power in low gear.

In low gear there are two driver gears and two driven gears. The speed reduction ratio is equal to the number of teeth on the first driver gear multiplied by the number of teeth on the second driver gear divided by the number of teeth on the first driven gear multiplied by the number of teeth on the second driven gear.

The speed reduction ratio in low gear would be equal to $\frac{18 \times 15}{30 \times 30} = \frac{270}{900} = \frac{3}{10}$. This shows that the speed is reduced to 3/10 of the driver gear speed.

If the pinion gear is turning at 500 turns a minute and the speed reduction ratio is 3/10, what will be the speed of the propeller shaft? It will be

$\frac{3}{10} \times 500 = \frac{1500}{10} = 150$ r.p.m. (revolutions per minute).

So the propeller shaft will turn 150 times a minute.

Now look at second gear. The first sliding gear has been shifted to fit together with the second speed gear. This gear is larger than the low gear. There will be less loss of speed and less increase of power. The pinion gear turns the drive gear and the second gear turns the sliding gear and the propeller shaft.

$$\frac{18 \times 24}{30 \times 24} = \frac{432}{720} = \frac{6}{10} = \frac{3}{5}$$

If the pinion gear turns at 500 r.p.m., the speed of the propeller shaft would be 300 r.p.m. This speed is twice as fast as in first or low gear.

In high gear the propeller shaft connects directly with the pinion. There is no speed reduction. The propeller shaft will turn 500 r.p.m. when the pinion gear turns at 500 r.p.m.

In reverse the pinion gear turns the drive gear, the reverse gear turns the idler gear, and the idler gear then turns sliding gear No. 2. Placing the idler gear between the reverse gear and the sliding gear is what reverses the movement.

The reverse gear is the slowest of all. The car moves the slowest but has the most power when in reverse. The speed reduction in reverse equals

$\frac{18 \times 12}{30 \times 30} = \frac{316}{900} = \frac{6}{25}$. This means that for a pinion speed of 500 r.p.m., the speed of the propeller shaft in reverse would be 120 r.p.m.

In neutral the sliding gears do not mesh with any of the gears on the countershaft. The engine can run in neutral without turning the propeller shaft.

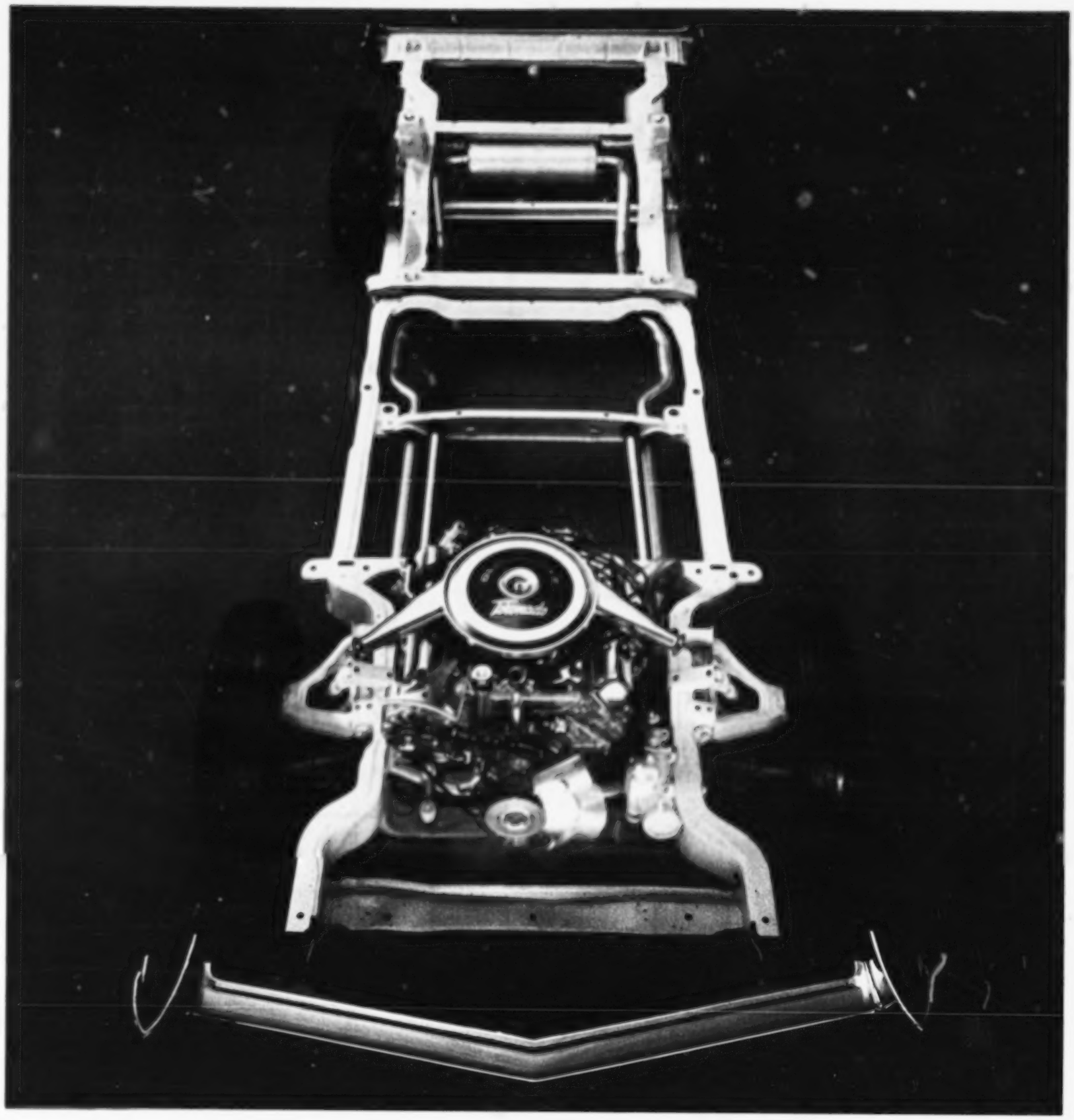
What has been given here as speed ratios is an example only. Our example has been simplified so as to explain it more easily. Some cars have four speeds forward. Some trucks have several speeds in reverse as well as many speeds forward.

PUZZLE 2. MAKES OF CARS

(Across only)

1. Pedestrians sometimes have to_____cars.
2. This car is made in England, and is often used by royalty.
3. Its nickname is "Caddy."
4. Chevy is another name for this car.
5. The American or the Ambassador.
6. The Starfire, F-85, or F-88.
7. This car has an Indian name.
8. Henry_____made this car.
9. This car has the same name as the silver liquid in a thermometer.
10. The Barracuda is the_____sports car.
11. The Imperial is made by this company.

(Answer on page 119)



OLDSMOBILE TORONADO

This view of the '66 Oldsmobile Toronado chassis clearly shows the relocation of all power train parts ahead of the passenger compartment. It shows the advanced torsion bar suspension system, and the absence of rear-end power train components or parts.

OLDSMOBILE TORONADO

(Technical Description)

Oldsmobile engineers have developed the front-wheel-drive Toronado. It is 211 inches long, only 52.8 inches high, and built on a 119-inch wheelbase.

The Toronado design no longer has the transmission hump and driveline tunnel. It has an advanced torsion bar suspension system. All power train parts are located under the hood.

The Toronado V-8 engine has 385 horsepower. Improved engine breathing and better carburetion give better performance.

A new four-barrel carburetor, the Quadrajet, increases air induction. Primary stages are 22% smaller and use a triple venturi for finer, more stable mixture control. Venturi are tubes used to regulate gas and air mixture in the carburetor. The new carburetor provides improved idling and increased economy. Secondaries are 44% larger, and use more exact fuel control called "air valve metering."

Air valve metering provides correct air-fuel ratios during acceleration and high performance operation. A single fuel reservoir with just one inlet needle and one float gives a constant fuel supply in any driving situation.

A new choke is mounted in the intake manifold. This choke can better sense engine temperatures.

A large dual snorkel air cleaner with a resin-treated filtering element supplies air to the Quadrajet. The tapered snorkels make less noise.

Larger intake valves, large throat size in the head, and less restrictive larger intake manifold branch areas, provide improved engine breathing. A high-lift profile camshaft and larger valve lifters also raise engine output.

The Toronado has an adapted Turbo Hydra-Matic transmission. This transmission is new in construction and power transfer.

Transmission power flow has to be reversed so that driving torque can be applied to the front wheels. Power flow is reversed by dividing the standard Turbo Hydra-Matic into two units.

The variable stator torque converter is attached in the usual way. The gear sets and controlling elements are rotated 180 degrees. They are enclosed alongside the converter. A two-inch-wide, multiple-link chain rotates counterclockwise. It transfers torque from a drive sprocket at the rear of the converter to a driven sprocket at the rear of the gear sets.

A simple spline shaft connects transmission gear output with the differential. The differential is fastened directly to the transmission.

The Toronado's differential uses a planetary gear set rather than the standard ring gear-pinion. Differential torque is split between two front drive axles. One is connected to the planetary gears. The other is connected to an internal sun gear. Each axle-driveshaft has inboard and outboard constant velocity universal joints. This construction lets the shafts have upward, downward, forward, or rearward motion needed for independent front suspension.

Special shock absorbers for fast-reacting steadiness are mounted at an angle. Wheel caster and camber can be easily adjusted with an eccentric cam assembly in the upper control arm, rather than by the usual shim method.

Standard power steering for the Toronado has an overall ratio of 17.8 to 1. Lock-to-lock is about 3½ turns; conventional steering is nearly 5 turns. A special shock absorber adds to steering control.

Four shock absorbers are used to dampen rear spring wind-up and for the most controlled braking. They also stop wheel hop, and give a smoother, quieter ride.

Oldsmobile's Toronado is the only car to use four rear shock absorbers.

A new brake drum has been designed for the Toronado. The brake drum provides quick heat loss for improved brake life and reduced fade characteristics. Enlarged brake linings are used for self-adjusting shoes. Shoes on a brake are curved parts of the brake. These curved parts press against a wheel to make friction and to slow or stop movement.

The Toronado has a new self-equalizing accelerator cable that operates the carburetor. The simple throttle device includes a spring-loaded down shift detent to keep the "kick-in" feel when passing.

Another Toronado feature is its retractable headlamp system. This is completely automatic. When the headlamp switch is pulled on, the lamp automatically rises to the open position in seconds. Pushing the switch to the park or off position automatically retracts the lamps.

THE AIRPLANE

All airplanes, no matter what kind of engines they have, are acted upon by four forces: lift, thrust, gravity, and drag.

Lift. The upper part of a plane's wing is curved slightly. As the plane moves forward, air passing over the wing is made to travel faster and farther than the air passing under the wing. The air pressure from under the wing is greater than that from above the wing. This causes the wing to be lifted up into the air. There is a basic rule that explains this: the pressure of a fluid -- in this case air -- decreases as the speed of the fluid -- or air -- increases.

Thrust speeds the plane on its way. The propeller of the airplane is shaped a little like an airplane wing. Its front surface is curved, and its back surface is almost flat. Air pressure is greater against the back of the propeller when the propeller is turned by the engine. This pushes the plane forward. The push forward is the thrust. The jet plane's thrust is the reaction to gases escaping backward.

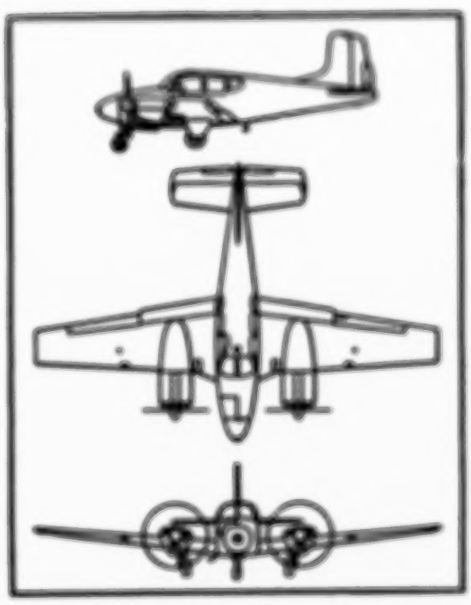
Gravity acts against lift. Gravity pulls the plane toward the earth.

Drag slows down a plane's progress. Air has substance, as does all other matter. The airplane has to push the air aside. The resistance from the air slows down the forward speed of the plane. Eddy currents form in the air in back of the exposed parts of the plane. An eddy current has a turning or whirling movement. These eddy currents, or eddies, make more resistance to forward movement. The drag is made up of air resistance at the front and eddies at the back of the exposed parts.

When an airplane is traveling at a constant speed in level flight the four forces are in balance: the lift is equal to the gravity and the thrust is equal to the drag.

BEECHCRAFT D95A TRAVEL AIR

BEECH AIRCRAFT CORP., Wichita 1, Kansas



The Beechcraft Travel Air can carry four or five people and their luggage more than 1,000 miles nonstop. The fuel consumption averages 18 gallons an hour. A runway of no more than 1,000 feet is needed for takeoff and landing. The Travel Air is used in business and industry.

SPECIFICATIONS

Span 37 ft. 10 in.; Length 25 ft. 11 in.; Height 9 ft. 6 in.; Empty Weight 2555 lb.; Gross Weight 4200 lb.; Wing Loading 21.1 lb. per sq. ft.; Power Loading 11.7 lb. per bhp; Engines Two Lycoming IO-360-B1B, 180 hp normal rates; Fuel Capacity 112 gal.; Propeller 72 in. 2-blade Hartzell, hydraulically controlled, continuously variable pitch, full feathering; Wing Area 199.2 sq. ft.; Aileron Area 11.5 sq. ft.; Flap Area 21.5 sq. ft.; Fin Area 16.97 sq. ft.; Rudder Area 6.63 sq. ft.; Stabilizer Area 27.4 sq. ft.; Elevator Area 15.0 sq. ft.

PERFORMANCE

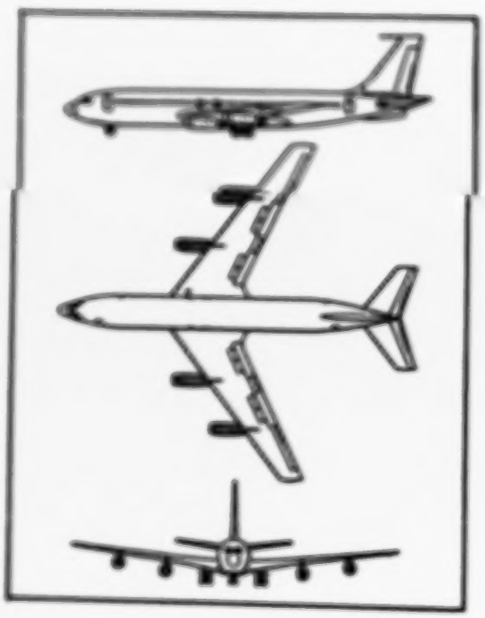
Maximum Speed 210 mph at 180 hp at 2700 rpm at Sea Level; Cruise Speed 200 mph at 135 hp at 2450 at 7500 ft.; Landing Speed 70 mph; Rate of Climb 1250 fpm at Sea Level; Service Ceiling 18,100 ft.; Absolute Ceiling 19,950 ft.; Range with Maximum Fuel Load 1170 mi.

BOEING 707

THE BOEING COMPANY, Seattle 24, Washington

The Boeing 707 first flew in 1957. Airlines began using them in 1958. There is a military model called the Boeing KC-135 -- a multi-purpose tanker-transport. There are many commercial models of the 707. The models most used to fly across the oceans are the 707-320 and the 707-420.

These big four-engine planes weigh 158 tons when fully loaded. Some models of the 707 are built with turbo-jet engines, while others have turbo-fan engines. The models used for coast-to-coast flights are lighter and faster than the ocean hopping 707's.



SPECIFICATIONS

Span 130 ft. 10 in.; Height 42 ft.; Length 144 ft. 6 in.; Engines four Pratt & Whitney JT3C-6 turbo-jet, with 13,000 lb. thrust; JT3D-1 turbofan engines produce approximately 17,000 lbs. of thrust. Gear tricycle, main undercarriage units, four-wheel trucks, dual nose wheels.

PERFORMANCE

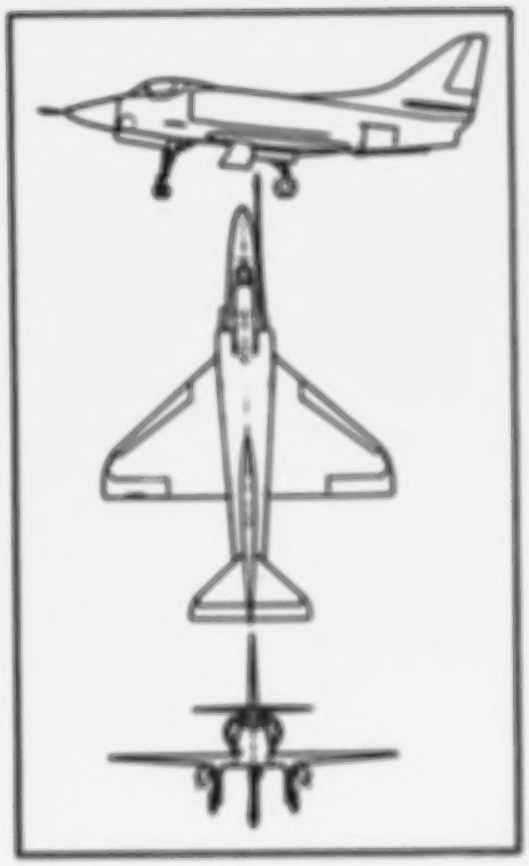
Cruise speed 581 mph; Cruising altitude 25,000 to 40,000 ft.

DOUGLAS A-4 SKYHAWK ATTACK BOMBER

DOUGLAS AIRCRAFT CO., INC., Santa Monica, Calif.

The A-4 Skyhawk made its first flight in 1954. It is small enough to work from carriers without folding wings. It has the power to carry out long-range missions with nuclear weapons, bombs, missiles, rockets, guns, and other weapons.

It can be refueled from tanker aircraft. The A-4 Skyhawk itself can be changed to a tanker by adding outside fuel tanks.



SPECIFICATIONS

Span 27 ft. 6 in.; Length 41 ft. 4 in.; Height 15 ft.; Gross Weight 15,000 lb.; Engine Wright J52; Guns Two 20 mm.; Bomb-rocket-missile capability on 5 external racks.

PERFORMANCE

Range Transcontinental; Speed 600-700 mph class.

F-27F PROPJET TRANSPORT

FAIRCHILD HILLER CORP., Hagerstown, Maryland

The Propjet Transport is used by many air lines and private companies. The F-27F is a new coast-to-coast model with a maximum range of about 3,300 miles. It can operate from short runways and unimproved fields.

The F-27F can carry from 36 to 44 passengers depending upon how the cabin is equipped. The cargo version can carry 12,000 pounds.

SPECIFICATIONS

Span 95 ft. 2 in.; Length 77 ft. 6 in.; Empty Weight 21,561 lb.; Operational Weights 42,000 takeoff, 37,500 landing; Engine Rolls-Royce Dart RDa 7/Mark 529-7H, 1990 shp at 15,000 rpm takeoff; Fuel Capacity 2368 gal.; Propeller Rotol, four blade, constant speed; Wing Area 754 sq. ft.; Aileron Area 37.6 sq. ft.; Total Flap Area 136.9 sq. ft.; Vertical Tail including dorsal 190 sq. ft.; Rudder Area (aft of hinge line) 33 sq. ft.; Horizontal Tail Surfaces 172 sq. ft.; Elevator Area (aft of hinge line) 34 sq. ft.

PERFORMANCE

Cruise Speed 300 mph at 14,200 rpm at 20,000 ft.; Rate of Climb 2200 fpm at Sea Level; Service Ceiling 32,700 ft.; Range with Maximum Fuel Load 3300 mi.

FAIRCHILD HILLER TURBO-PORTER

FAIRCHILD HILLER CORPORATION, Hagerstown, Maryland

The Turbo-Porter is a single-engine all-purpose airplane. It can operate from very small, unprepared fields. The plane can seat eight people, including the pilot. Seats can be removed to carry cargo. As an ambulance it can carry two stretcher patients and three attendants.

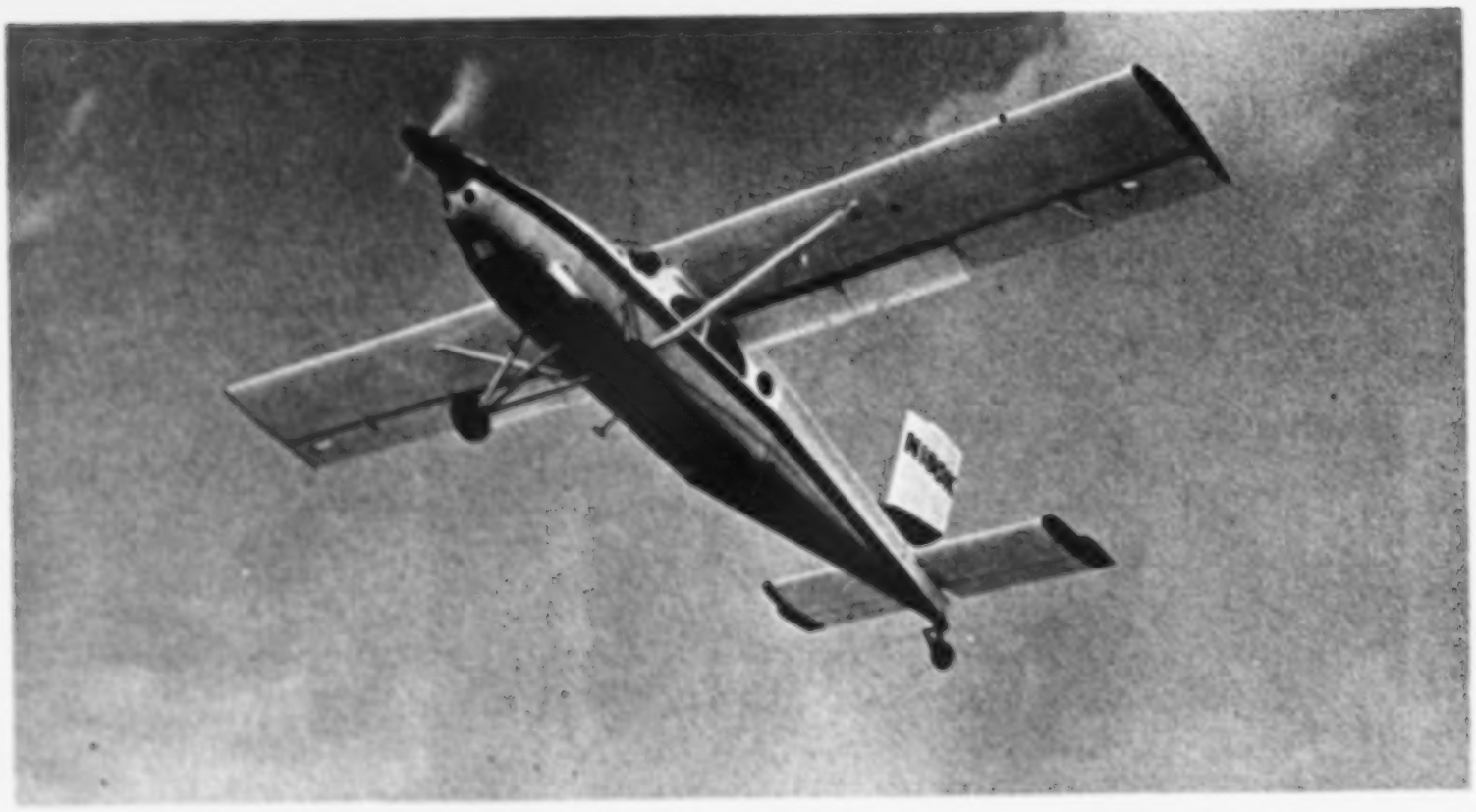
It can also be used for aerial photography, dropping supplies, and ground spraying. It can be equipped with floats, retractable skis, or oversized low-pressure tires for many different jobs.

SPECIFICATIONS

Span 50 ft., length 36 ft., empty weight 2,270 lbs., gross weight 4,850 lbs.; useful load 2,500 lbs.; two integral wing tanks have total capacity of 130 U. S. gallons. Wing area 310 sq. ft. Turbomeca Astazou engines deliver 530 shaft hp at takeoff; 480 continuous. Oil capacity, 2.1 gals. Also available with Pratt & Whitney PT6 and Garrett TP331 engines.

PERFORMANCE

Cruise speed 140 knots. Range 550 n.m. plus 30-minute fuel reserve. At max. gross weight on standard day with no wind, Turbo-Porter can take off within 360 ft. ground roll and land within 181 ft. Service ceiling at max. load is 28,000 ft.

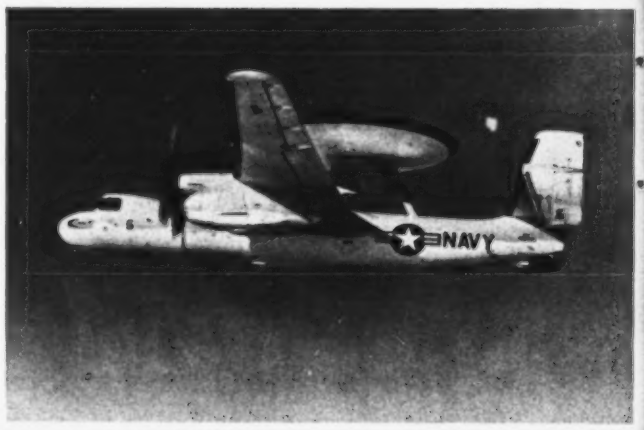


GRUMMAN E-2A HAWKEYE

GRUMMAN AIRCRAFT ENGINEERING CORP., Bethpage, Long Island, New York

The Hawkeye is used by the Navy. It is an important plane because it is able to give early warning of attack and provide intercept control. This is possible because of the radar, computers, and high-speed data relay system it carries.

It has a five-man crew and can stay in the air for a long period of time. The Hawkeye has two Allison T-56 A8 turbo-prop engines.



SPECIFICATIONS

Span 80 ft. 7 in.; Length 56 ft. 4 in.; Height 16 ft. (to top of radome); Engines Allison T56-A8, 4050 hp normal rated.

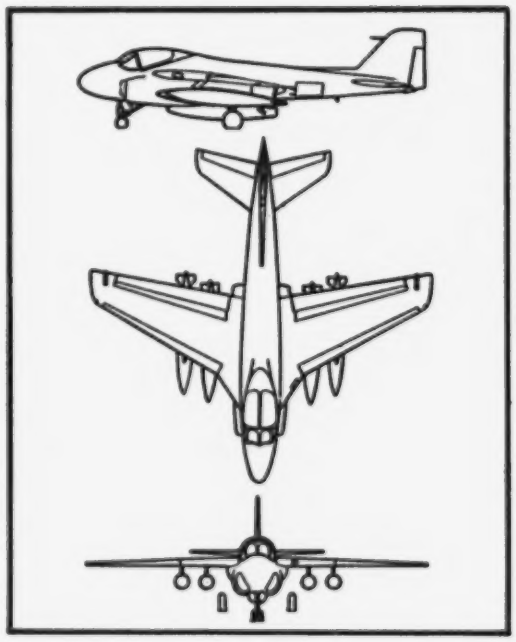
APPLICATIONS

Early warning of attack and intercept control aircraft.

GRUMMAN A-6A INTRUDER

GRUMMAN AIRCRAFT ENGINEERING CORP., Bethpage, Long Island, New York

The Intruder is a very versatile airplane. It is used by the U.S. Navy as a low-altitude carrier-based attack aircraft. It can fly long distances and deliver a nuclear punch. It can also give local support to ground troops with conventional weapons.



SPECIFICATIONS

Wing Span 53 ft.; Length 53 ft. 3 in.; Height 15 ft. 1 in. (to tip of tail); Engines two J-52-P6 Pratt & Whitney, rated at 8,500 lbs. of thrust each.

PERFORMANCE

All data are classified.

B-58 HUSTLER

FORT WORTH DIVISION OF GENERAL DYNAMICS CORP., Fort Worth, Texas

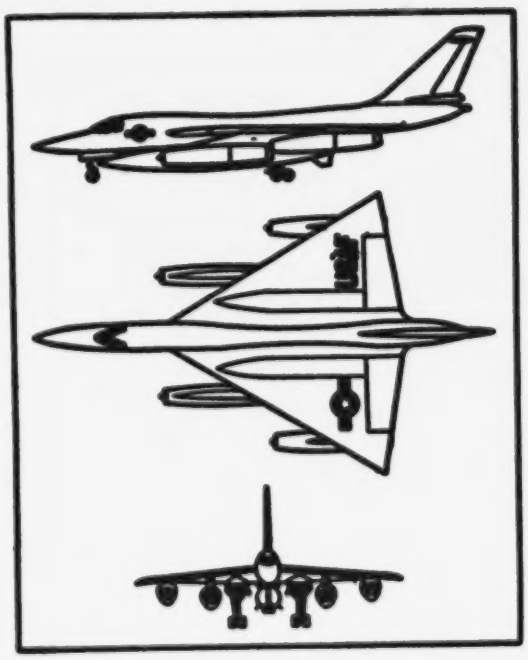
The B-58 Hustler is the first supersonic bomber. It was designed for use by the Air Force's Strategic Air Command. The Hustler has a number of weapon loads mounted on the outside of the plane. The first crew escape capsules to be used on any aircraft are part of the B-58.

SPECIFICATIONS

Gross Weight over 160,000 lb.; Span 56 ft. 10 in.; Length 96 ft. 9 in.; Height 30 ft.; Engines Four General Electric J79-5A turbojet pod-mounted; Wing Area 1542 sq. ft.

PERFORMANCE

Maximum Speed over 1300 mph (Mach 2); Service Ceiling above 60,000 ft.; Range Intercontinental, with mid-air refueling; Design Bomb Load Nuclear; Crew Three; Fuel Capacity more than 15,000 gal.; Landing Gear tricycle (dual-wheel nose gear, eight-wheel truck main gear).



HUGHES 300 DELUXE

HUGHES TOOL COMPANY, Aircraft Division, Culver City, California

The Hughes 300 Deluxe is a three-passenger helicopter for commercial use. It has a fuel injection engine. The 300 Deluxe has all-around visibility. It is possible to order this model equipped to carry outside sling loads, litters, cargo, and floats.

The 300 Agricultural was built for spray work, and carries 60 gallons of spray and has 35-foot spray booms.

SPECIFICATIONS (300 DELUXE)

Main rotor diameter 25 feet 3½ inches; length 22 feet 4 inches; height 8 feet 3 inches; landing gear tread 6 feet 6½ inches; maximum gross weight 1670 lbs.; empty weight 950 lbs.; useful load 720 lbs.; engine Lycoming H10-360-AIA (fuel injection); 180 hp to 3900 feet; rpm range 2700-2900; fuel capacity 25 gallons (extra 25 gallon tank optional can be installed).

PERFORMANCE (300 DELUXE)

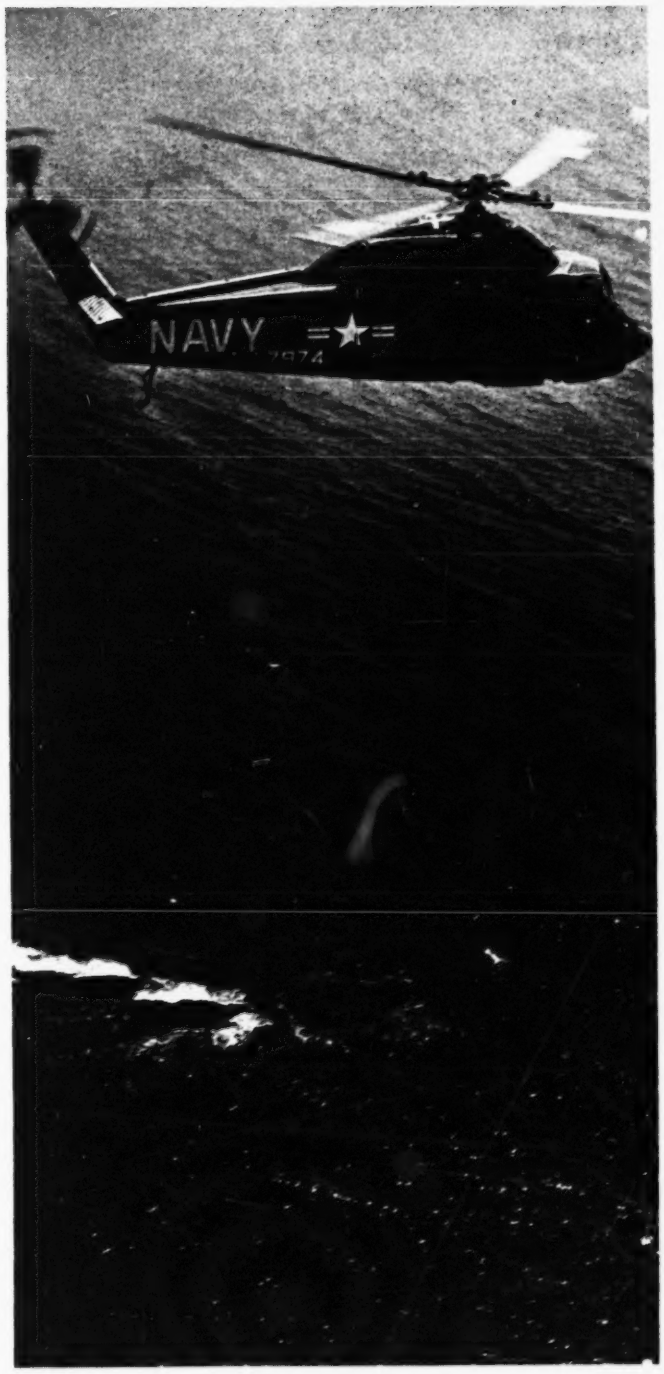
Maximum speed 87 mph; cruise speed 80 mph; economy cruise 66 mph; range 200 miles; endurance 3.3 hours; fuel consumption 8 gallons per hour; hover ceiling (IGE) 7700 feet; service ceiling 14,000 feet; rate of climb sea level 1450 fpm; rate of climb 5000 feet 1200 fpm.

KAMAN UH-2A SEASPRITE

KAMAN AIRCRAFT CORP., Bloomfield, Connecticut

The Navy's new, high-speed utility helicopter, the Seasprite, has many missions to perform. It serves plane guard duty with aircraft carriers.

It is used for search, rescue, aerial ambulance service, and personnel transport. It is used for submarine detection and is capable of attack. The Seasprite has advanced electronic stabilization and navigation gear.

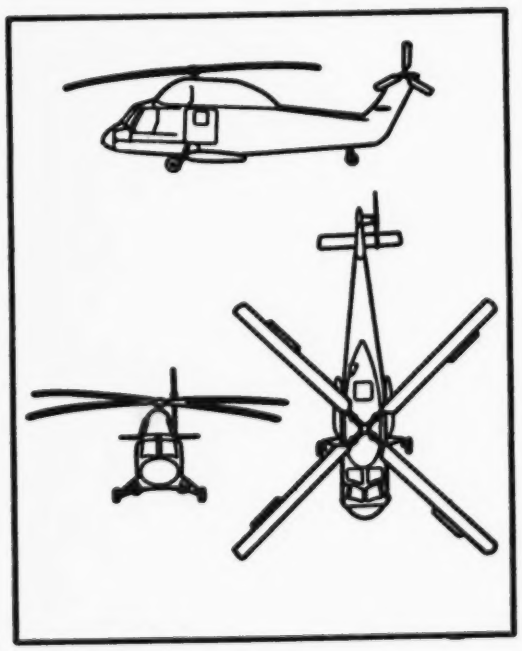


SPECIFICATIONS

Main Rotor Diameter 44 ft.; Length 52 ft. 2 in. (operation); Height 12 ft. 5 in.; Empty Weight 5052 lb.; Engine One General Electric T-58-8, hp military power 1250. Internal Fuel Capacity 276.0 gal.; Stabilizer Area 15.0 sq. ft.

PERFORMANCE

Maximum Speed, 163 mph; cruise speed, 151 mph; Rate of Climb, 1850 fpm; Service Ceiling, 18,500 ft.; Range with Maximum Fuel Load, 860 mi.; Gross Weight, 8,049 lbs.



LOCKHEED YF-12A ADVANCED INTERCEPTOR

Many of the details of this airplane are still very closely guarded secrets. This new plane provides the Air Force with a revolutionary interceptor which increases our capability to provide effective defense against missile-carrying enemy bombers.

SPECIFICATIONS

Details not released.

PERFORMANCE

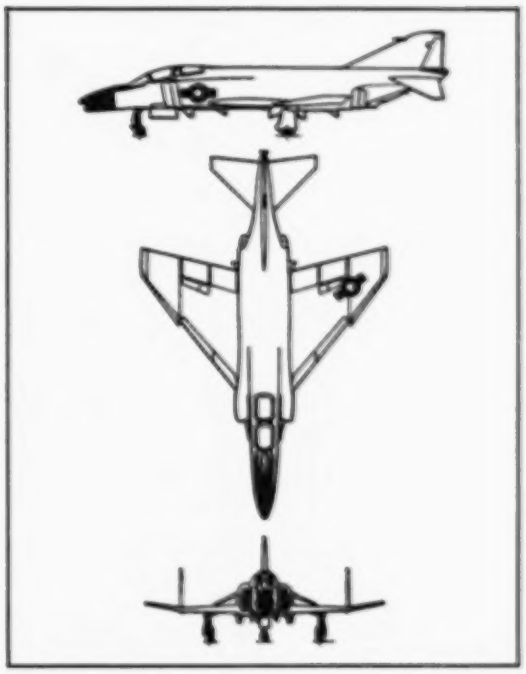
Speed: More than 2,000 miles per hour; Altitude: In excess of 70,000 feet; Engines: J-58, designed and built by Pratt & Whitney Aircraft Division of United Aircraft Corporation; Fire Control System: ASG-18, developed by Hughes Aircraft Corp.; Armament: AIM-47A (formerly GAR-9) air-to-air guided missile, developed by Hughes Aircraft Corp.

McDONNELL PHANTOM II

McDONNELL AIRCRAFT CORP., St. Louis 66, Missouri

The Phantom II is used by the U. S. Air Force, Marine Corps, and Navy. It is used as both a fighter and a reconnaissance plane. The fighter version of the airplane can carry over 8 tons of air-to-air guided missiles and air-to-ground weapons on the same flight.

The Phantom II serves to scout enemy territory, and provide air defense and ground support.

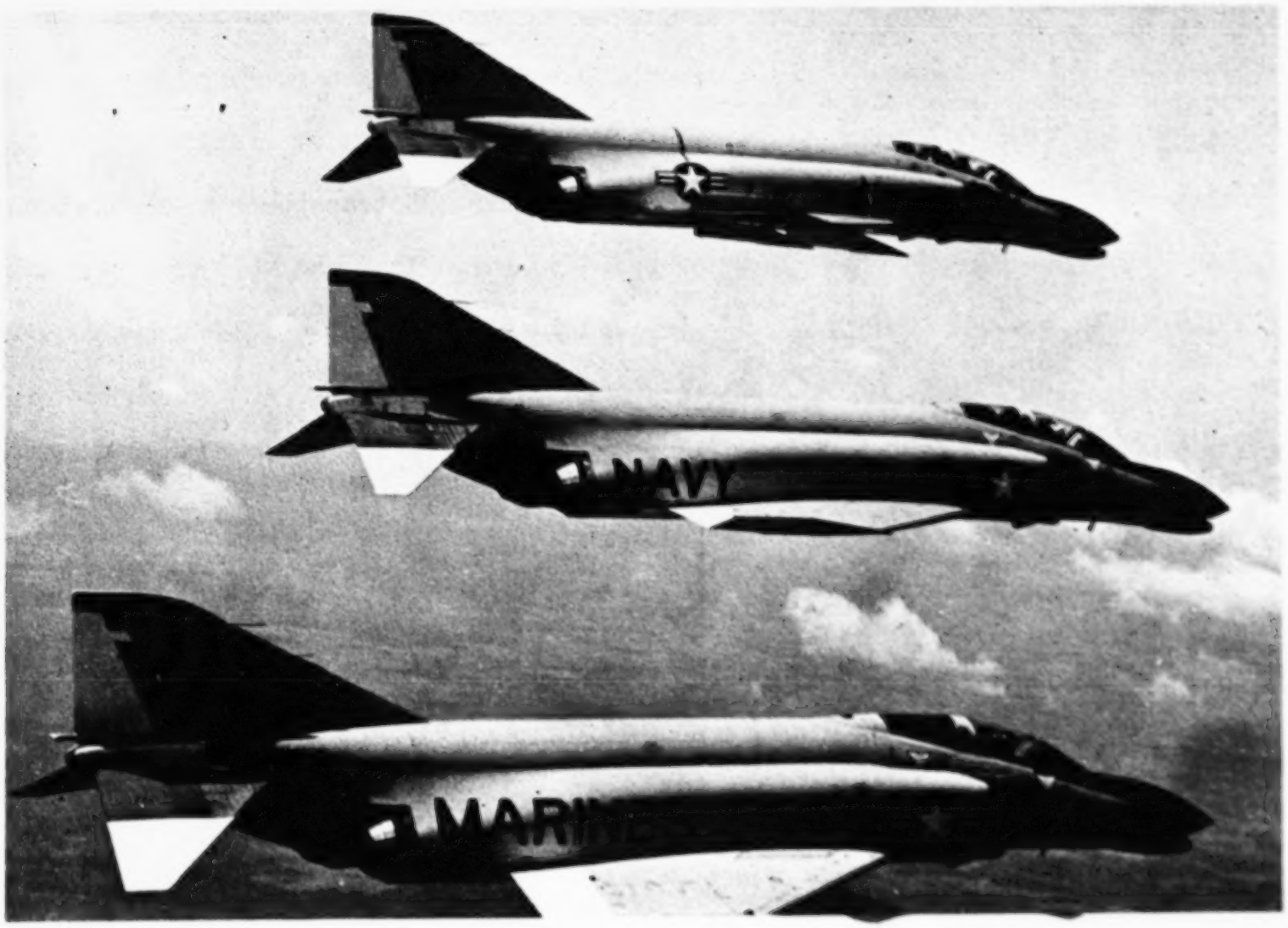


SPECIFICATIONS

Span 38 ft. 5 in.; Length 58 ft. 3 in.; Height 16 ft. 3 in.; Engines two General Electric J79-8 with afterburners, combined thrust 34,000 lbs.; Wing area 530 sq. ft.; Wing boundary layer control.

PERFORMANCE

Maximum speed 1,650-plus mph; Range with maximum fuel load 2,000-plus mi.



PIPER AZTEC C

PIPER AIRCRAFT CORPORATION, Lock Haven, Pa.

Many executives use the Aztec C for business trips. This twin-engine plane seats six. With the seats removed it has 120 cubic feet of cargo space for loads up to 1300 pounds. The 144-gallon fuel capacity provides a maximum range of 1320 miles.

PIPER APACHE 235 PA-23-235

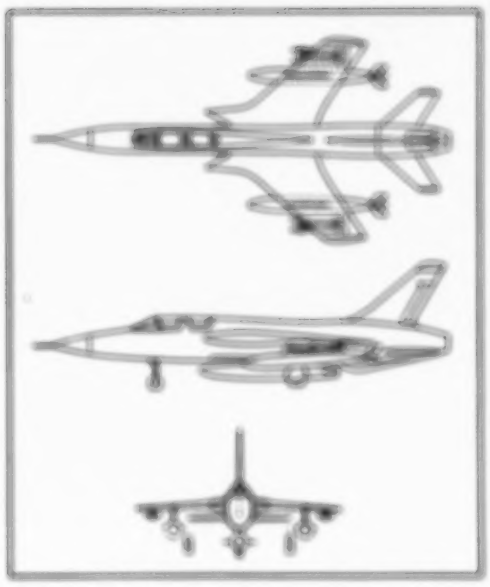
PIPER AIRCRAFT CORPORATION, Lock Haven, Pennsylvania

The new twin-engine Piper Apache 235 has a speed of 200 m.p.h. It combines speed, convenience, and economy. The Piper Apache has a long sleek hull, swept tail, and single-piece stabilator, and is powered by two Lycoming 235-h.p. engines. The standard 144-gallon fuel capacity gives it a range of over 1200 miles on many qualities of gasoline.

The Apache 235 transports a useful load of 2,065 pounds. It works well from short airfields, and take-offs and landings require less than 900 feet.

REPUBLIC F-105 THUNDERCHIEF

REPUBLIC AVIATION CORP., Farmingdale, L.I., N.Y.



The Thunderchief is an all-weather fighter-bomber. Its speed ranges from 200 miles per hour to over 1,400 m.p.h. The Thunderchief takes just 55 seconds to climb to 8,200 feet.

In this plane the pilot can make a round-trip, low- or high-level bombing mission in any weather, day or night, over any kind of country, without ever seeing the ground. It can carry a six-ton bomb load and has an automatic 20-millimeter cannon with a rate of fire of 6,000 rounds per minute.

SPECIFICATIONS

Span 34 ft. 11 in.; Length (F-105D) 64 ft. 5 in., (F-105F) 69 ft. 7 in.; Height (F-105D) 19 ft. 8 in., (F-105F) 20 ft. 2 in.; Engine Pratt & Whitney J75, 26,500 lb. thrust with water injection and afterburner.

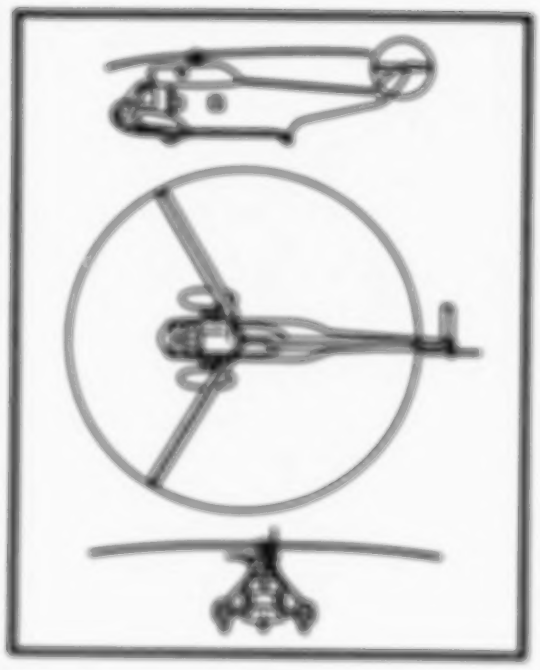
PERFORMANCE

Speed Mach 2; Altitude ceiling 50,000 plus.

SIKORSKY S-62;
HH-52A (Coast Guard)

SIKORSKY AIRCRAFT DIVISION, United Aircraft Corp., Stratford, Connecticut

The single-turbine S-62 is used by the U. S. Coast Guard as a search and rescue helicopter. It can carry a pilot, co-pilot, and 11 passengers. It can land on water as it has a boat-type hull. It can also operate from ice, snow, swamp, mud, and other surfaces. Oil companies use it to carry supplies to offshore drilling platforms.



SPECIFICATIONS

Main Rotor Diameter 53 ft.; Tail Rotor Diameter 8 ft. 9 in.; Length 44 ft. 7 in.; Height 16 ft.; Empty Weight 4,857 lbs.; Normal Gross Weight 8,100 lbs.; Useful Load 3,423 lbs.; Engine one General Electric T58-8 of 1,250 hp.

PERFORMANCE

Maximum Speed 110 mph; Cruising Speed 98 mph; Best Rate of Climb 960 fpm; Service Ceiling 10,200 ft.; Range 449 mi.

JET ENGINE

Jet engines are based on a scientific law. This law says that for every action there is an equal and opposite reaction. If you have seen a toy balloon with air escaping shoot quickly around a room, you have seen how this law works. The backward escape of the air from the balloon is the action. The opposite reaction is the forward movement of the balloon.

Air is drawn into the front of a jet engine by a compressor which is a series of fan-like blades mounted on a turning shaft. This air is compressed and is then sprayed with fuel as it enters the combustion chamber. A spark ignites the air-fuel mixture. This makes super-heated gases. These gases push against the combustion chamber of the engine and escape from the back of the engine.

This fast rush of gas backward causes the plane to move forward. On the way out, the gases strike turbine rotors mounted with small blades. This causes the rotors to turn. Since the turbine is mounted on the same shaft as the compressor, it therefore turns the compressor and

draws in more air. The simplest jet, the ramjet, is like a hollow tube fitted with a fuel combustion chamber. Air must be rammed into the ramjet, as it has no compressor. Air is brought into it by launching it from a "mother plane" at high altitude and at high speed. The ramjet supplies extra power for planes and missiles at high altitudes and at very high speeds.

The turboprop is like the turbojet, but its turbine also turns the propeller to help power the aircraft.

ROCKETS

The rocket engine works like the jet engine, but it does not "breathe" air. It can work at high altitudes and in space where there is no oxygen.

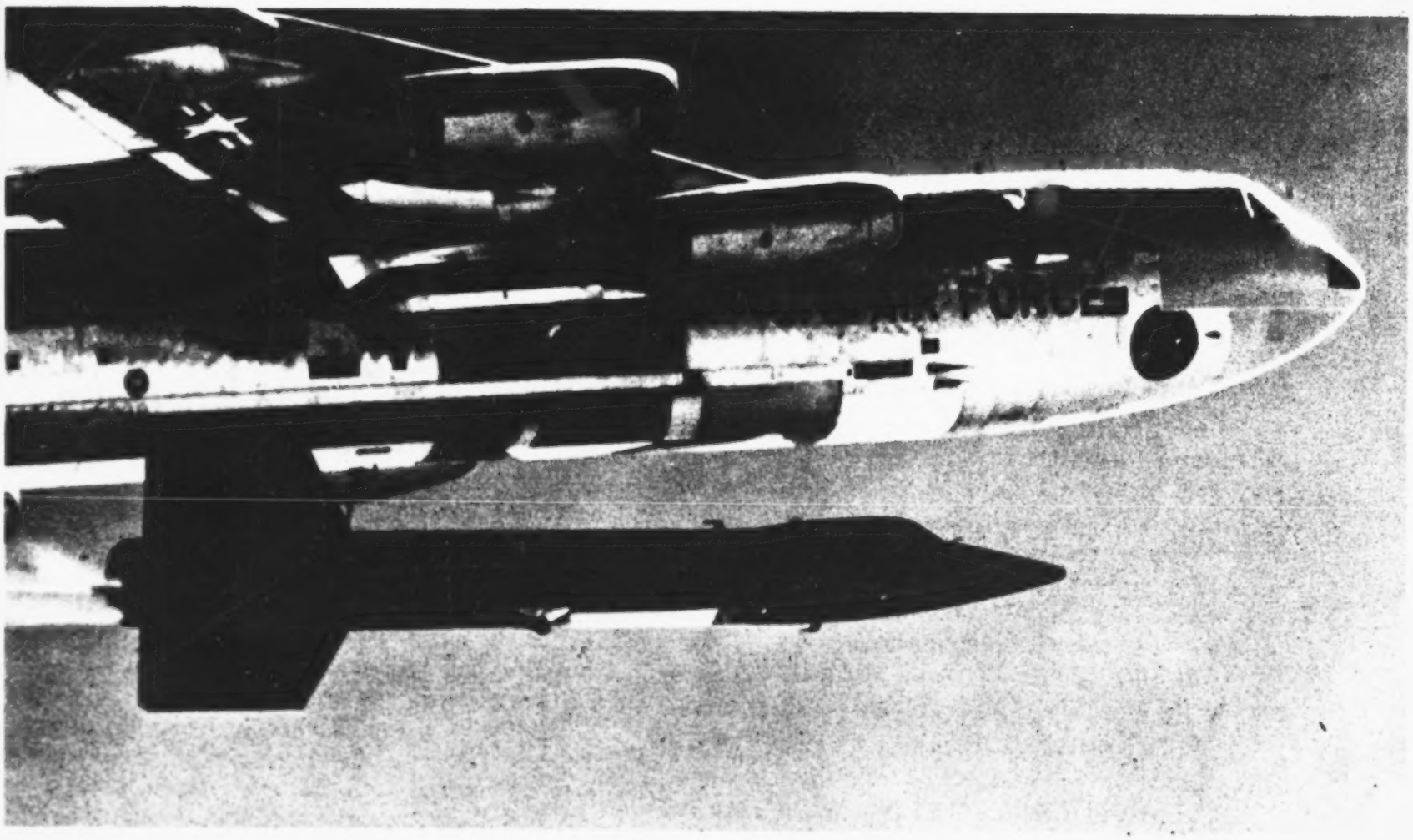
Rockets carry their own fuel and oxygen. Sometimes the oxygen or oxidizer is carried separately; sometimes it is combined with the fuels.

There are two types of rockets. The <u>solid-fuel rockets</u> are like those used in fireworks. Their fuel and oxidizer form a rubbery mixture or "grain" which is contained in a casing. When ignited, the grain burns

within the casing. Hot gases escape from the rear. These are usually used for small jobs. They may assist airplanes during takeoffs. They may supply extra power for airplanes and missiles in flight. Often they are used to supplement artillery and as armament on fighter planes.

Liquid-fuel rockets are more complex. They have many pipes, pumps, and valves to regulate the flow of both liquid fuel and oxidizer. When the mixture is ignited, hot gases are released. These gases make the rocket go.

A rocket engine does not operate long. A solid-fuel rocket may last about 15 seconds. A liquid-fuel rocket may last several times longer.



NORTH AMERICAN X-15

The X-15 is considered one of the most successful research airplanes ever built. Its mission is research at the edge of space. Someday one of the X-15's will take its place in the National Air Museum of the Smithsonian Institution.

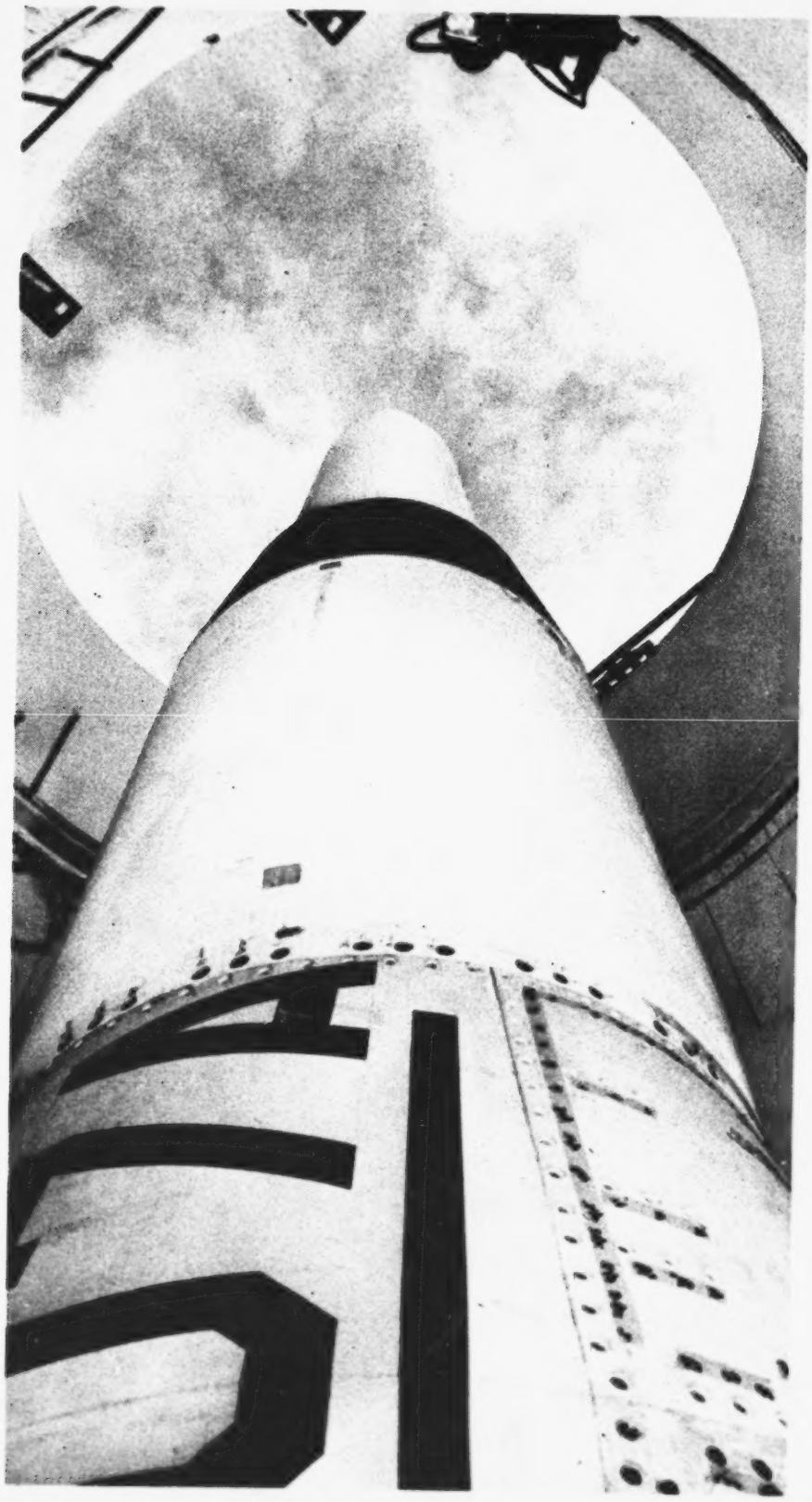
The X-15 is carried under the wing of a B-52 to an altitude of 45,000 feet or 8½ miles. Here, at a speed of nearly 600 miles per hour, the X-15 is dropped, and the pilot starts the rocket engine. Within a matter of seconds it is flying faster than the speed of sound, which is 760 m.p.h. In 30 seconds it is flying at twice the speed of sound.

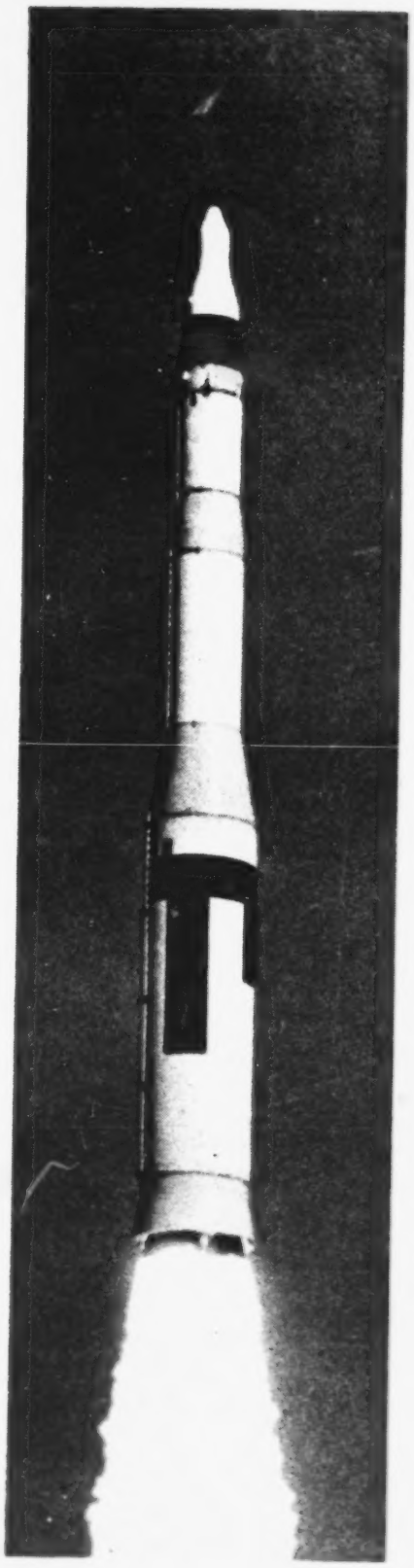
In 1963 the X-15 reached an altitude of 67 miles, more than three times as high as any other winged aircraft. On another flight, it reached a speed of 4,104 m.p.h.

At very high altitudes, the pilot controls the X-15 by reaction jets, like a spacecraft. He is weightless for brief periods, and the research plane re-enters the atmosphere very much like a spacecraft. Therefore, the X-15 can make research contributions for both aircraft and space flight.

Many things have been learned from the X-15. Now there is need for an even more advanced research craft. It is needed to aid in the development of supersonic commercial transports.

X-15

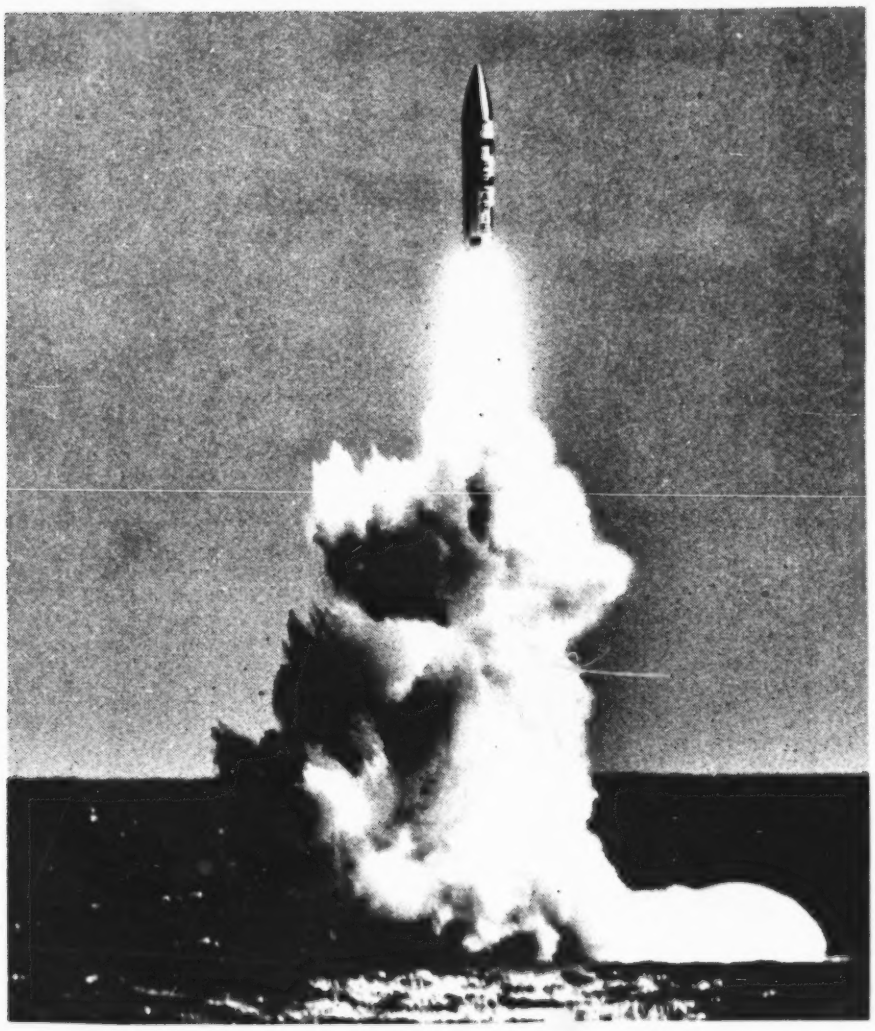




SURFACE TO SURFACE

MINUTEMAN

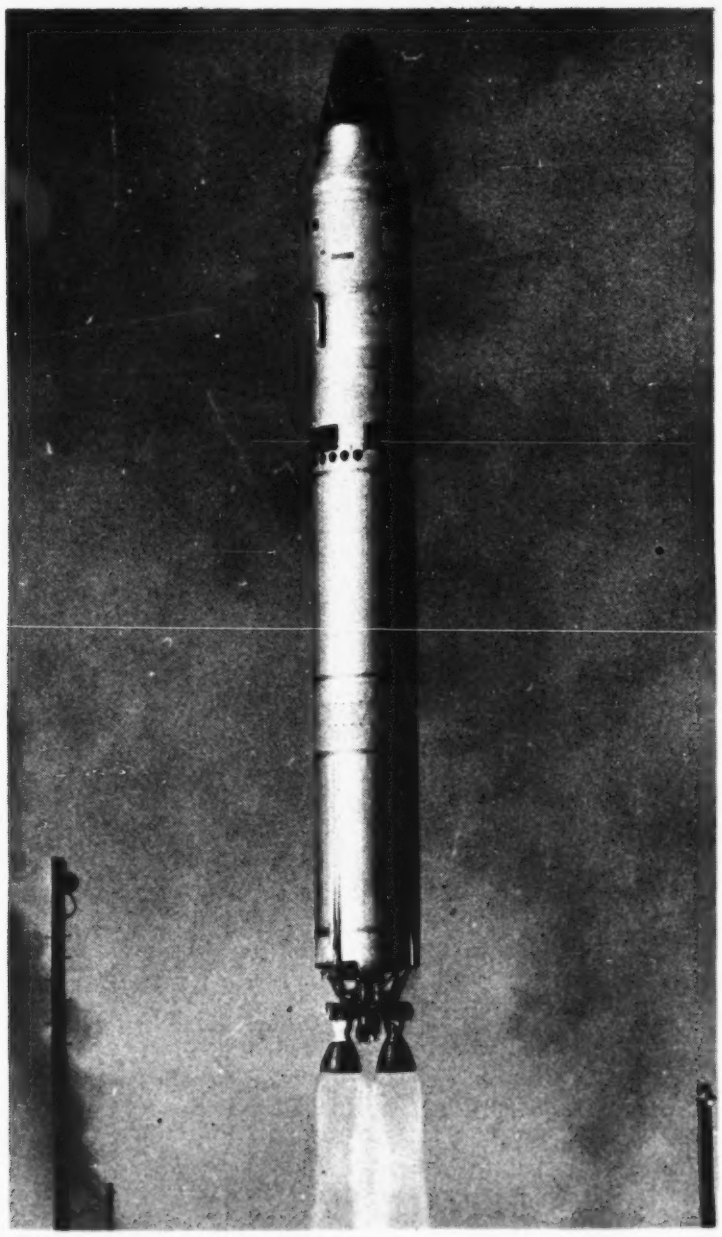
There were more than 700 Minuteman I weapons in service at the end of 1964. The Minuteman II, with many improvements, started tests in 1964. The Minuteman missiles are three-stage weapons powered by solid-propellant rockets. The Minuteman I has a range of over 6,300 statute miles.



POLARIS/POSEIDON

The A-3 is the latest model of the Polaris Fleet Ballistic Missile. It has a range of 2,500 nautical miles. All models are launched from nuclear-powered submarines. They are solid-propelled.

The Poseidon was developed by the Navy in late 1964. This is the fourth model of the Polaris, renamed Poseidon. It will have greater accuracy and payload capability. The Navy scheduled a total of 41 submarines to be Polaris-equipped during 1965.

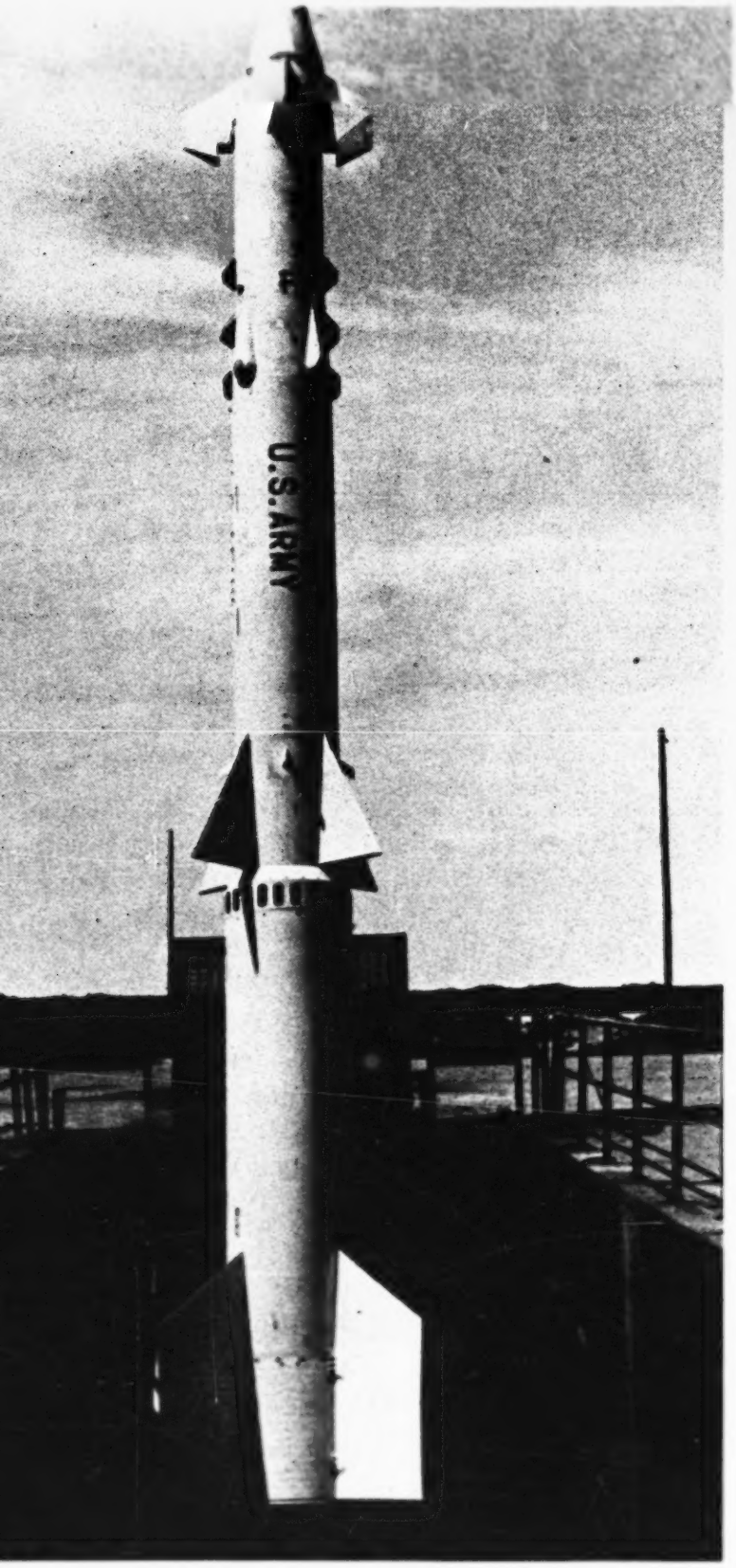


TITAN

The Air Force's Strategic Air Company uses the Titan missiles -- Titan I and Titan II.

Titan II has a range of over 6,300 miles. This missile is silo-launched and powered by storable propellants. The Titan II is a two-stage weapon. It has 430,000 pounds of thrust in the basic stage and 100,000 pounds of thrust in the second stage.

During 1964 there were 12 squadrons of the Strategic Air Command equipped with Titan missiles.



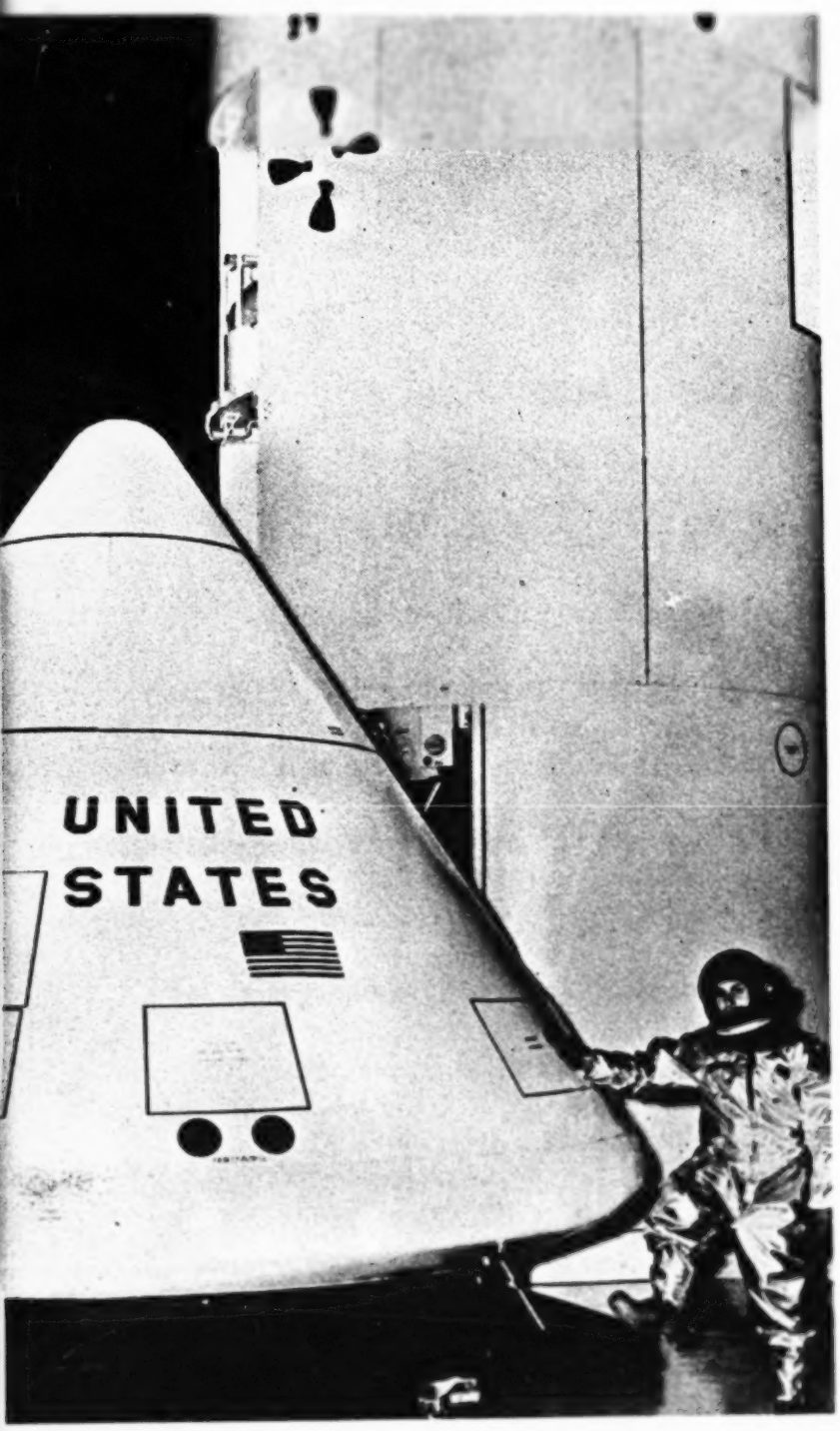
SURFACE TO AIR

NIKE X (Zeus and Sprint)

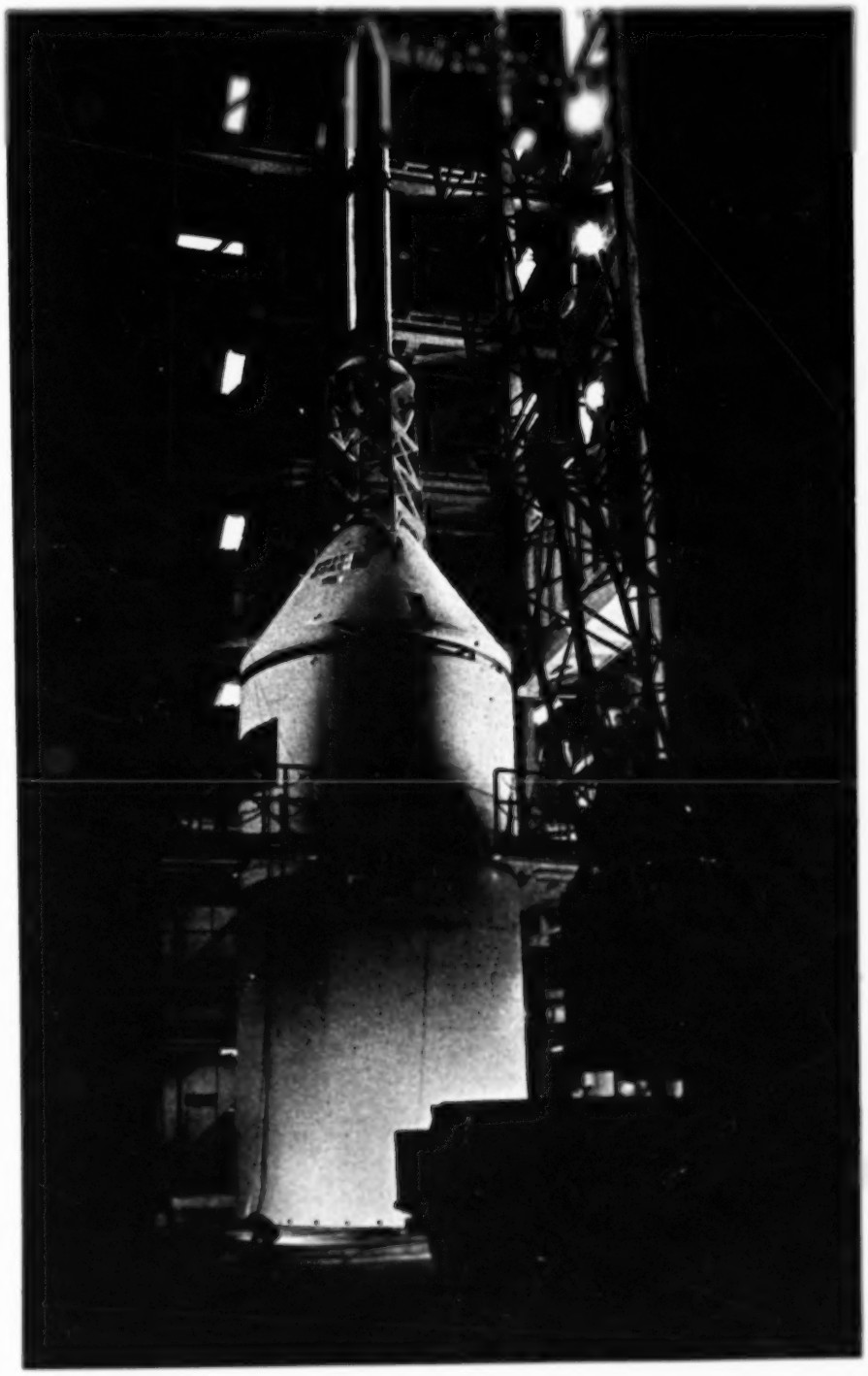
Nike X is the name for a complete Army defense system for use against attacking ICBM's and IRBM's. Two different types of interceptor missiles are used -- the Zeus and the Sprint. A battery of tracking radars and computers are on the ground.

The radars pick up, track, and choose targets. The radar data are given to computers which direct the intercept by radio contact with the missiles' guidance equipment.

The two missiles provide many intercept ranges and altitudes. Both are launched from underground cells. Zeus is a long-range missile. It is a three-stage, 48-foot missile with all stages solid-propelled. Sprint is a high-speed short-range weapon. Its intercept time is listed as "seconds." It has two solid-propelled stages.



1. Mock-ups of the command and service modules.



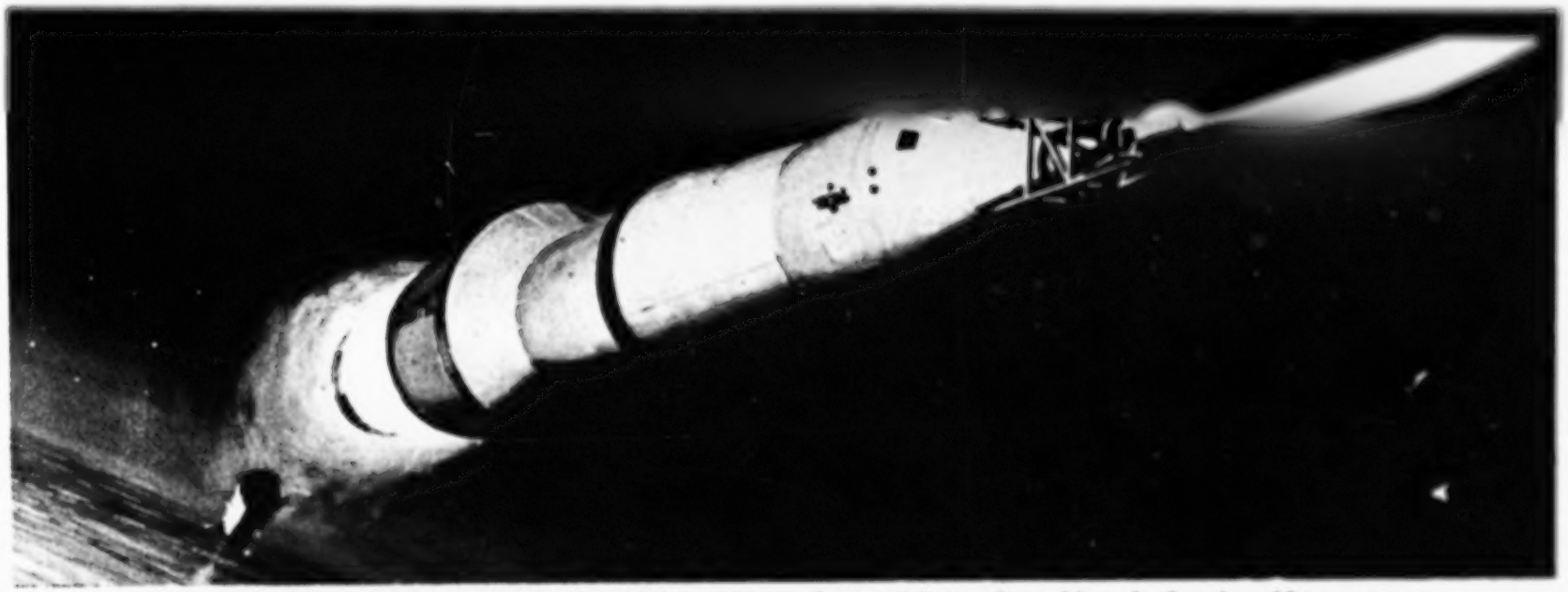
2. Here the command and services modules are put together.

SPACECRAFT

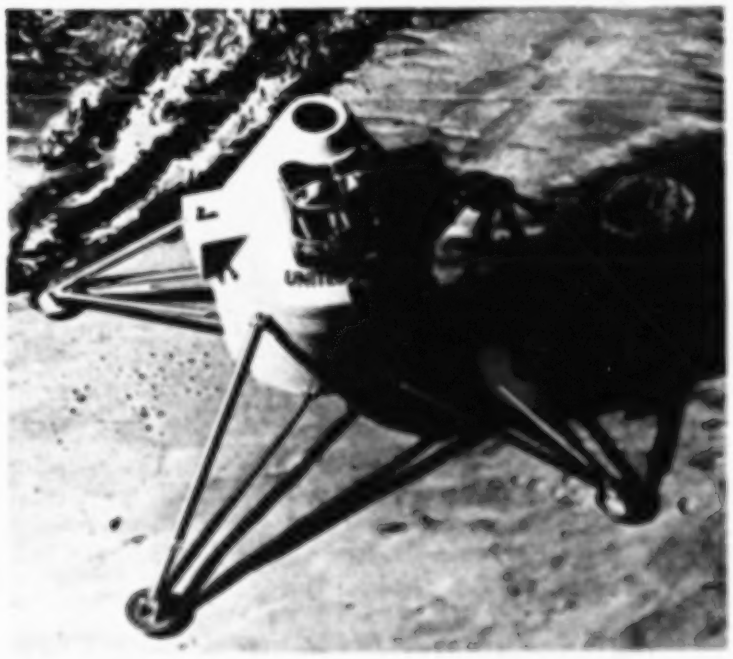
Project Apollo is the United States program for putting two men on the moon. The Apollo spacecraft will make many flights before the moon landing. First, Apollo will orbit the earth. Orbit the earth means to circle the earth.

Plans call for a manned flight around the moon before the landing try. This flight will allow three astronauts to get a good look at the moon's surface. The astronauts could decide on the best place for their landing.

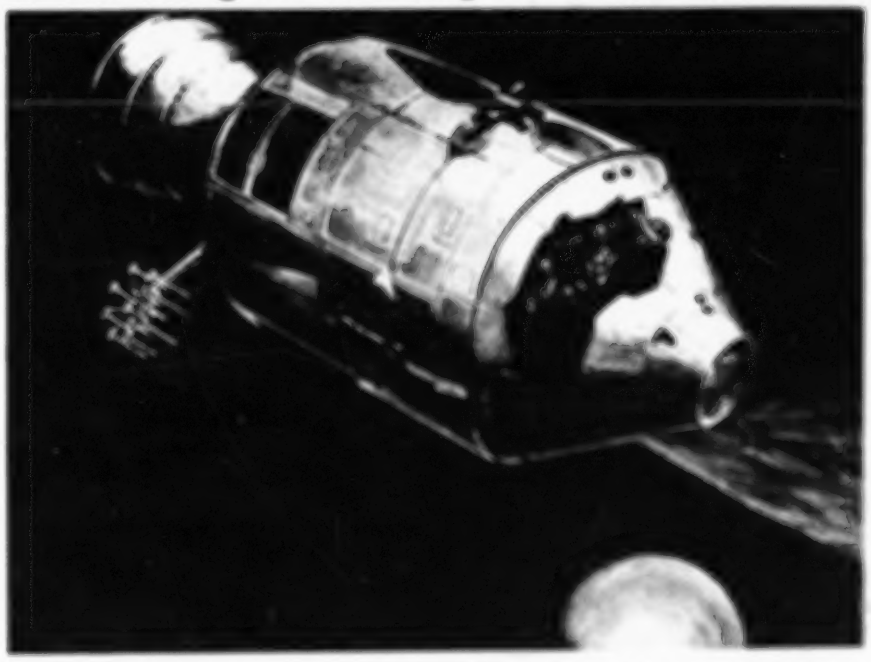
The most important mission of the three-man Apollo spacecraft would be the moon landing. Two men would separate from the Apollo and land on the moon



3. Apollo will look like this after launching for the trip to the moon.



4. LEM as it might look on the moon.



5. Apollo returning to earth. It has shed some parts because it no longer needs them.

in a small craft called a Lunar Excursion Module, or LEM. The Apollo spacecraft would not land. It would stay in orbit around the moon. The third astronaut would stay with the Apollo.

The two astronauts who land will study the moon. They will find out as much information as they can. Then they will get back into the LEM and go back to join the orbiting Apollo. The Apollo will then return to earth.

The moon landing is planned for 1969.

There are three sections to the Apollo. One section is the command module during the flight. The service module contains the units to make the spacecraft work after the launching. The LEM is the third section.

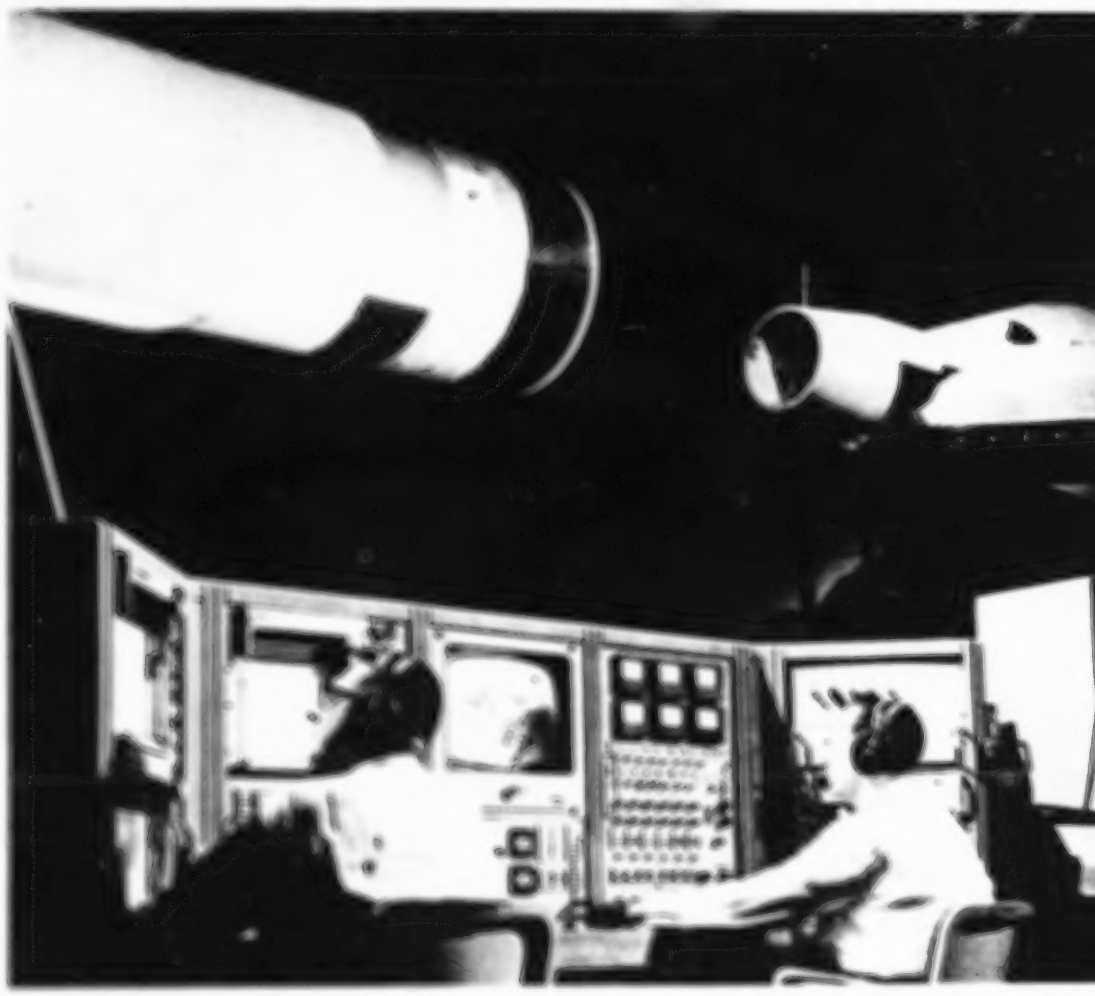
The Apollo weighs about 90,000 pounds.

PROJECT GEMINI

Gemini is a manned spacecraft. Many flights have been made in Gemini. Two astronauts in Gemini have orbited the earth for two weeks. While in orbit they joined up with another spacecraft containing two other astronauts. We call this meeting a rendezvous.

Future Gemini spacecraft will be able to stay in space for as long as a month.

Gemini is a two-section spacecraft. It weighs about 6,900 pounds. Plans call for ten missions, but more missions might be planned.



MANNED ORBITAL LABORATORY

The Manned Orbital Laboratory is a project to find out the military usefulness of man in space. This is an Air Force program. The laboratory will be a spacecraft that can stay in orbit for 15 to 30 days.

The laboratory will find out how man can perform military operations without gravity. Gravity is the force that keeps man on the ground. Without gravity, man becomes weightless.

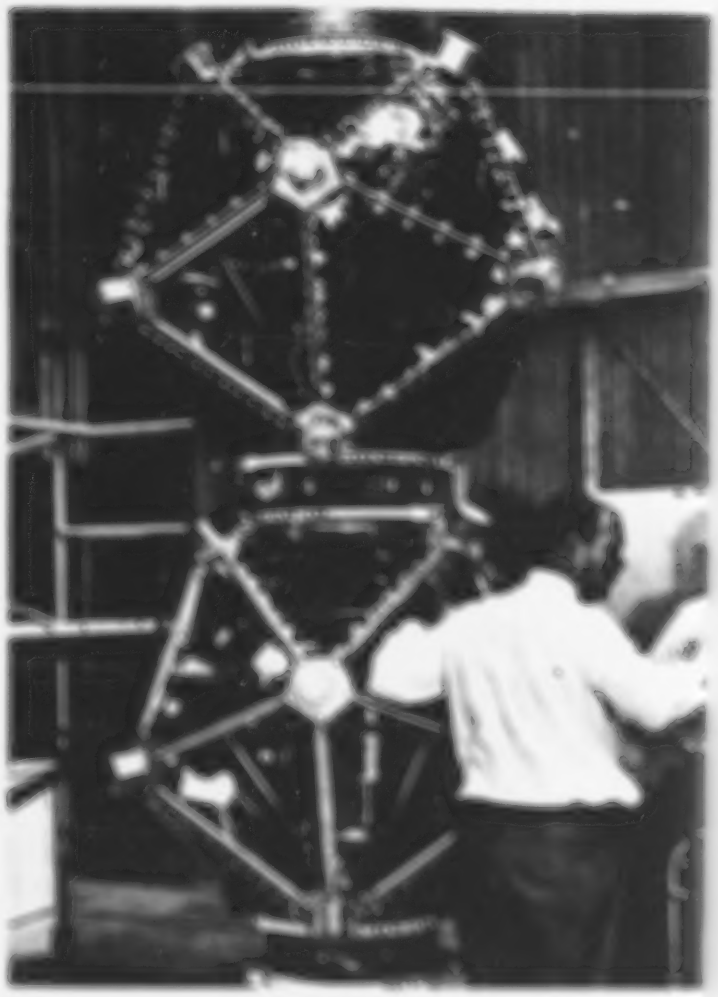
The laboratory will also be used to test special equipment. A two-man Gemini capsule attached to the Manned Orbital Laboratory will orbit in space. When their work in the MOL is finished, the astronauts will return to earth in the Gemini spacecraft, leaving the MOL behind.

TELSTAR

Telstar is the first active-repeater communications satellite.

Telstar has been used to send television programs from overseas to the United States and from the United States overseas. Telstar has also been used to send telephone, telegraph, and radio messages around the world.

Telstar first went into orbit on July 10, 1962. On May 7, 1963, Telstar II was put into orbit.



EXPLORER

Explorer is not the name of a spacecraft. Explorer is a code name for a series of scientific satellites. These satellites are not all alike.

Explorer satellites have been used to find out about radiation. They have studied the density of the atmosphere. The atmosphere means all the air around the earth. Density means compactness. They have performed other scientific missions, also.

The picture shows a satellite called "Injun." There is a cylinder on top that contains another inflatable satellite. Something inflatable can be blown up with air or gas, as a balloon can.

SURVEYOR

Surveyor is a moon research spacecraft. Surveyor will make a "soft landing" on the moon. The spacecraft will land at a speed slower than the speed of a parachute landing on earth.

Surveyor weighs 750 pounds. It has three television cameras, which can be used to examine the surface closely.

Surveyor has a soil sampler also. The soil sampler will dig into the moon's surface and tell us what it finds.

Some of the Surveyor instruments will measure the characteristics of the moon, and some will measure radiation on the moon. Other instruments will measure the moon's magnetic fields.

Seven Surveyor spacecraft are being built.

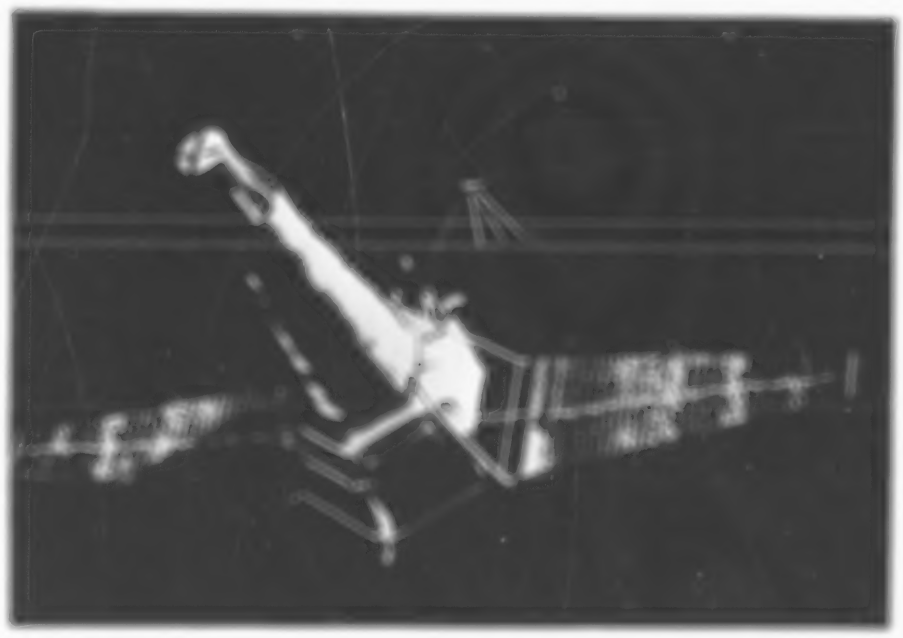
RANGER

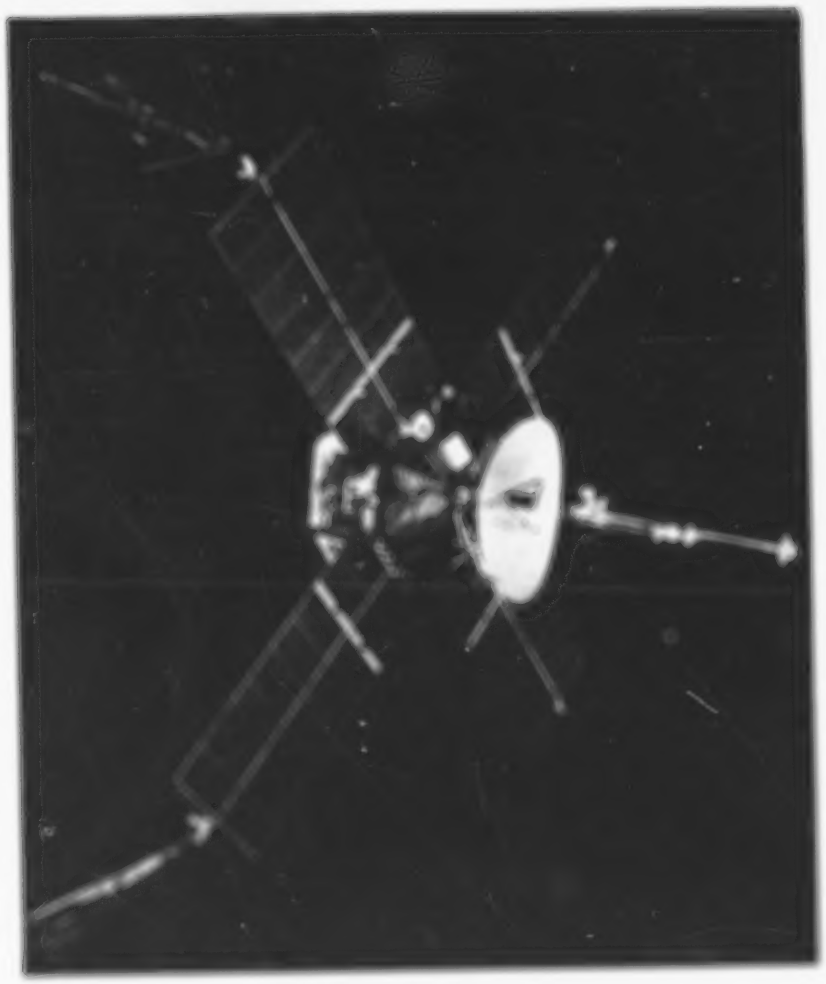
Ranger was used to take pictures of the moon. The series of Ranger flights ended in March 1965.

The early flights failed, but the last three were successful. More than 15,000 close-up photographs of the moon were taken on the successful missions.

The pictures were taken at different altitudes and angles. Pictures were taken of different parts of the moon's surface.

These pictures helped scientists learn more about the moon. The pictures helped narrow down the number of possible places where a manned moon spacecraft might land.



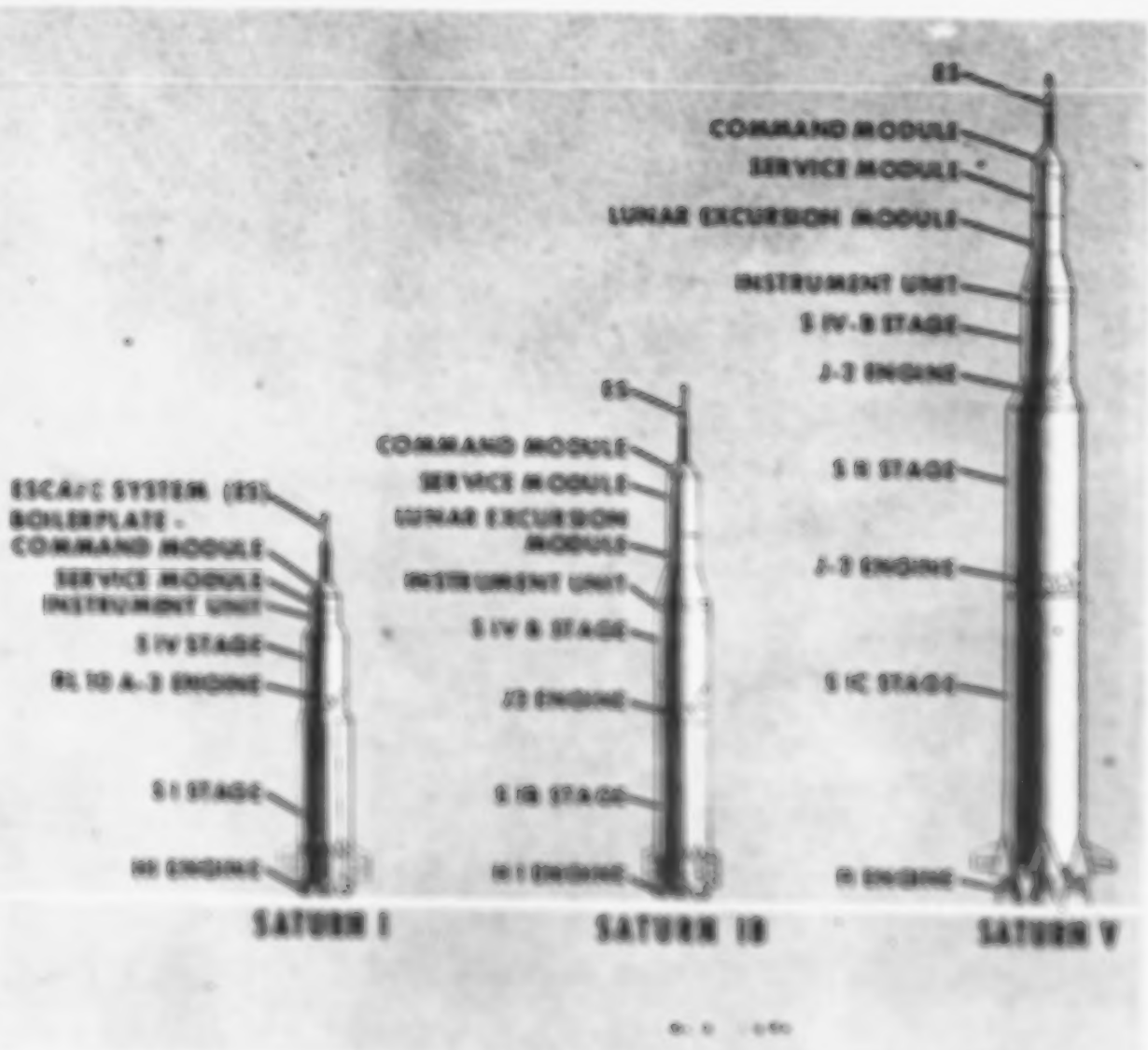


MARINER MARS

Mariner Mars was launched on November 28, 1964. It is sometimes called Mariner 4.

Mariner Mars was built to make the 350,000,000-mile trip to the Red Planet and pass within 5,400 miles of Mars in July of 1965.

This craft had a single camera. The camera took 21 still photographs of Mars. The spacecraft was equipped with instruments to study the atmosphere around Mars. Also, Mariner Mars had instruments to gather information while flying between the earth and Mars. After flying past Mars, Mariner 4 continued on an endless orbit of the sun.



Scale comparison and stage details of the Saturn booster family.

Saturn I on initial launch from Cape Kennedy, Fla.

SATURN SERIES

There are three types of Saturn launch vehicles. These vehicles use four different types of rocket engines in different combinations.

Saturn I made its first flight on January 29, 1964. Saturn I SA-9 was used to launch the Pegasus spacecraft. Saturn I can send ten tons into earth orbit. It is a two-stage booster. The lower stage has eight engines. These eight engines have a total of 1,500,000 pounds thrust. The upper stage has six engines with a total of 90,000 pounds thrust.

Saturn IB has two stages also. The lower stage has 1,600,000 pounds thrust. The upper stage has a single 200,000-pound thrust liquid hydrogen engine. Saturn IB can launch 18 tons into low earth

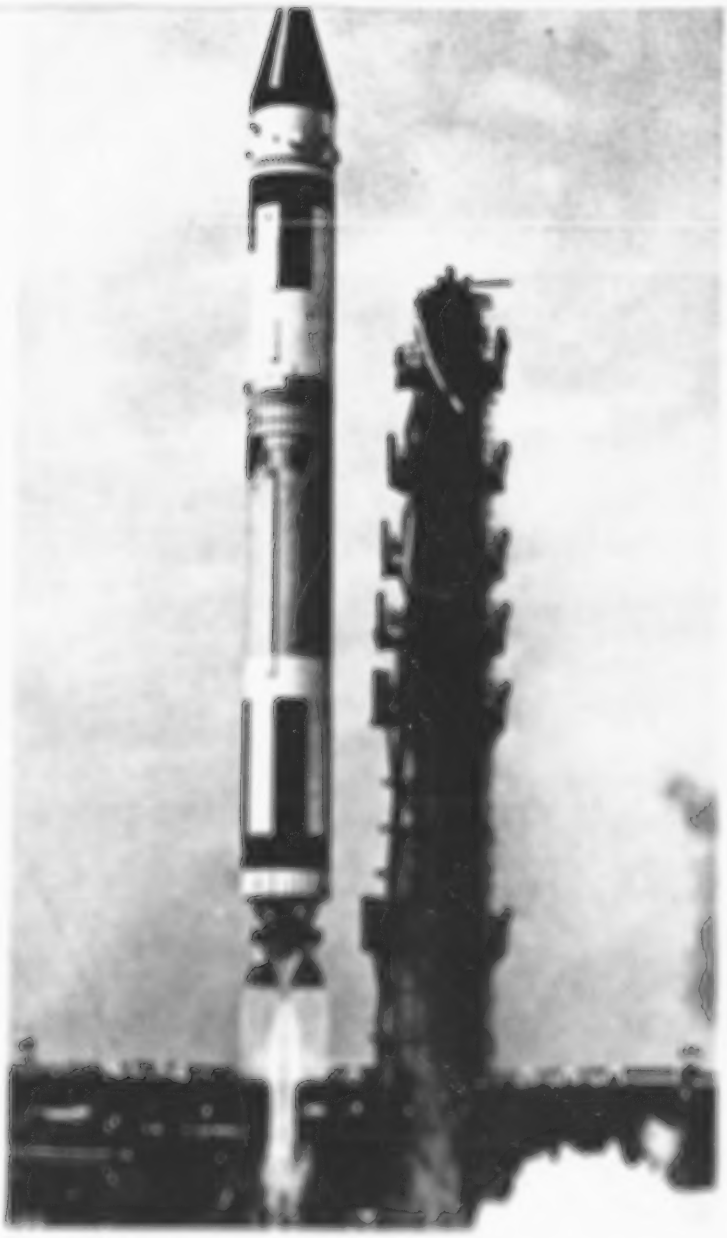
Artist's conception of Saturn V/Apollo launch

Production line check of liquid hydrogen J-2 engines

orbit. It will be used for the first earth orbital flights of the Apollo spacecraft late in 1966 or early in 1967.

Saturn V is a superbooster. It will be used to send American astronauts to the moon. It is a three-stage vehicle. Saturn V can send 45 tons to the moon. It can place 120 tons in earth orbit. The first stage is propelled by five engines, each developing 1,500,000 pounds of thrust for a tremendous total of 7,500,000 pounds. The second stage has five J-2 engines with 1,000,000 pounds total thrust. The third stage has one J-2 engine.

The first research and development flight of the Saturn V is planned for 1967.



Titan III-A on initial flight test

Titan III-C launch vehicle, which can orbit 25,000 pounds

TITAN SERIES

The Titan series of three launch vehicles is adapted from the Titan II ICBM. It is used by both NASA and the Air Force.

Titan II is the booster for the Gemini program. It is 90 feet tall and is a two-stage vehicle. The lower stage has 430,000 pounds thrust. The upper stage has 100,000 pounds thrust. Titan II and the other vehicles in the series do not need an ignition system. They use a special fuel. The fuel and the oxidizer ignite as soon as they mix.

Titan III-A uses the Titan II and two solid-fuel rocket engines -- one on either side. These two engines give the final thrust into orbit.

Titan III-C uses the Titan III-A and two large solid-propellant motors in the basic stage. Each motor has 1,000,000 pounds thrust. Titan III-C will be used in 1967. It will launch the Manned Orbital Laboratory.

AGENA

Agena is an upper stage, but it is also used as a spacecraft when the whole 25-foot stage goes into orbit. The Agena weighs one ton.

Agena plays an important part in manned flight. It is the target vehicle for rendezvous and docking operations.

Agena's main engine can be restarted in space. Gemini Agena has a control system that can handle 96 commands from the astronauts or from ground stations.

NUCLEAR POWER

Automobiles are run by gasoline engines. Some trains and trucks have diesel engines. Some airplanes have jet engines. There are also forms of transportation run by steam, electricity, or even human power.

One of the newest forms of power for transportation is nuclear power. Nuclear power is also known as atomic energy.

Nuclear power is used for our fastest submarines. These submarines have more endurance than older types. They can travel farther without refueling. They can stay under water longer.

The Nautilus, the first nuclear-powered submarine, set records for underwater speed and endurance. A few pounds of uranium gave this submarine enough fuel to go thousands of miles at top speed.

Before there were nuclear submarines, the waters of the Arctic could not be used for naval operations because the heavy ice prevented frequent surfacing. Also, it was not possible to refuel as often as necessary. Now these waters are open to nuclear submarines.

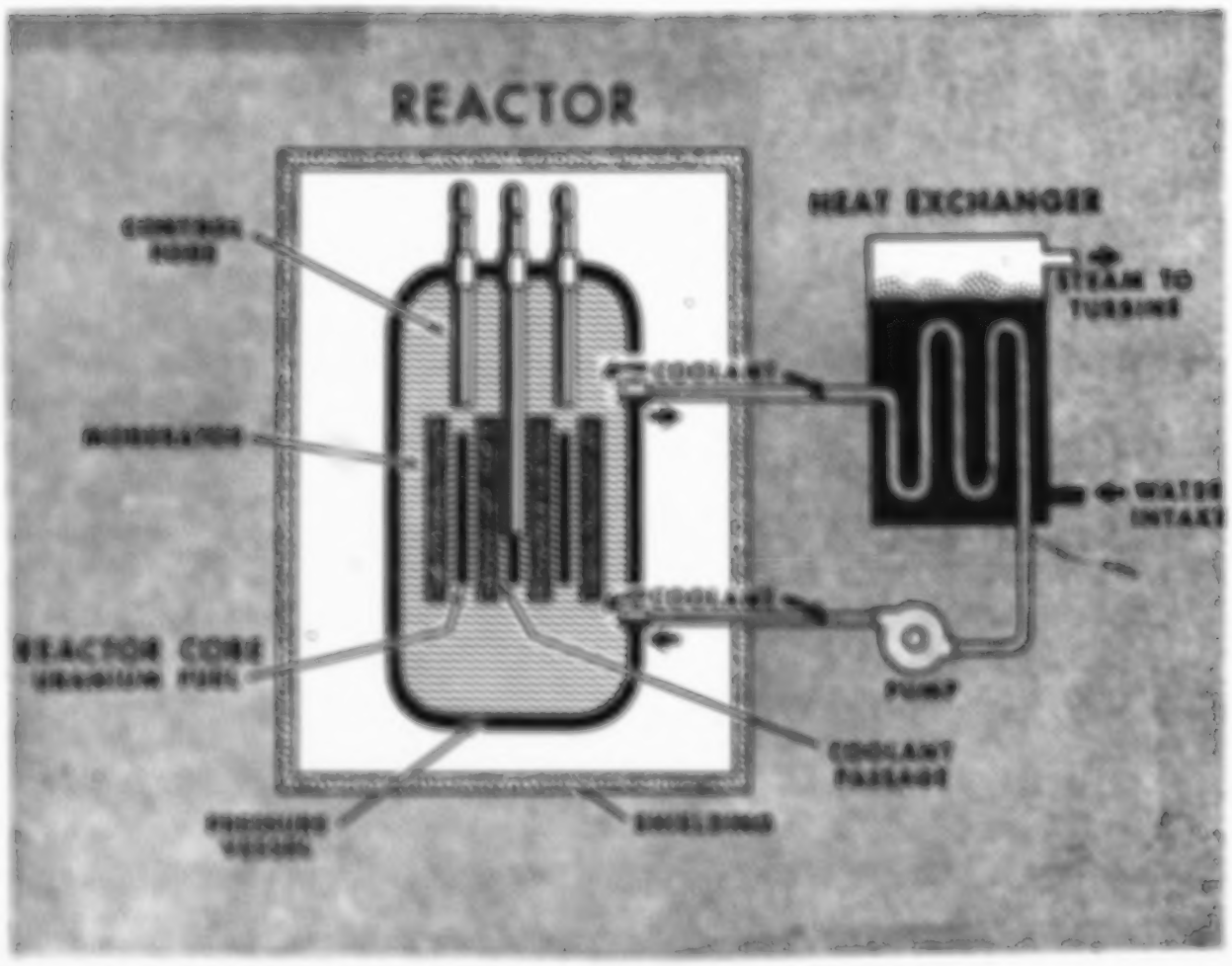
HOW ATOMIC ENERGY IS RELEASED

Releasing atomic energy is like building a fire.

An atomic fuel is called a fissionable material. Fission means splitting. A fissionable material is one that can be split. In order for atomic energy to be released, the atoms must be split. Atoms are too small to see. An ordinary drop of water contains sextillion atoms (6,000,000,000,000,000,000,000).

The fireplace for an atomic fuel is called a reactor. The first reactor was called a "pile" because it contained "piles" of graphite blocks and uranium slugs. The reactor keeps the fission under control. The control and safety rod mechanism of the reactor controls the fission. The rod slows down the fission. It speeds up again when the rod is pulled out.

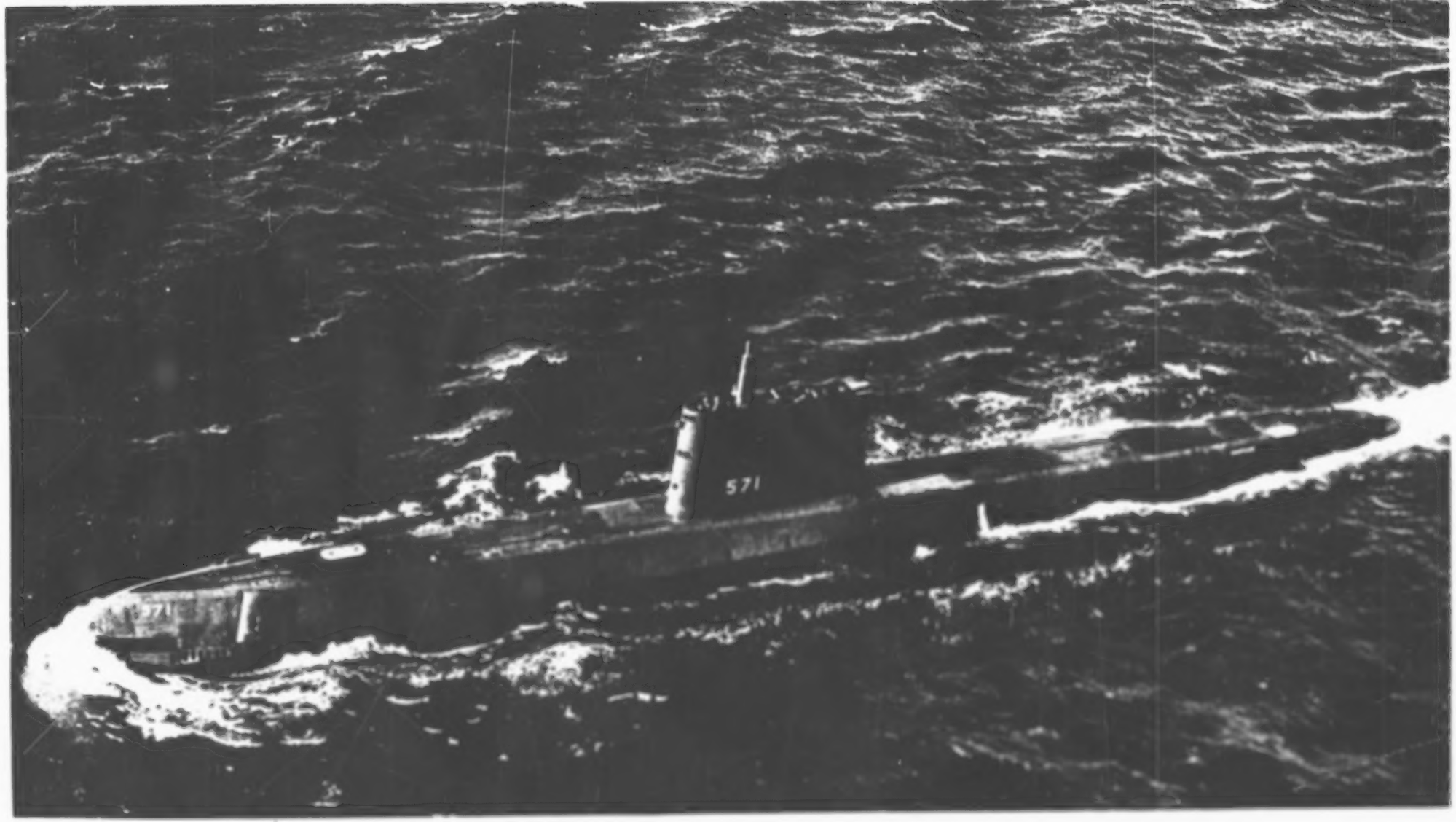
A fire may be started by a match. Fission is started by a trigger. This trigger is a very small particle called a neutron. A neutron is part of an atom. The neutron starts the splitting of the atoms. As the atoms split, more and more neutrons are released to split more atoms.



HOW A NUCLEAR REACTOR DRIVES A SUBMARINE

Splitting of uranium 235 atoms in a reactor produces heat. This heats the water running through the reactor. The water is pumped to a heat exchanger, where it makes steam before it returns to the reactor. The steam from the exchanger turns the steam turbine. This turbine drives the propellers and the ship.

If the turbine drove an electric generator, electricity from a power plant like this could be used for many other tasks.



U.S.S. NAUTILUS

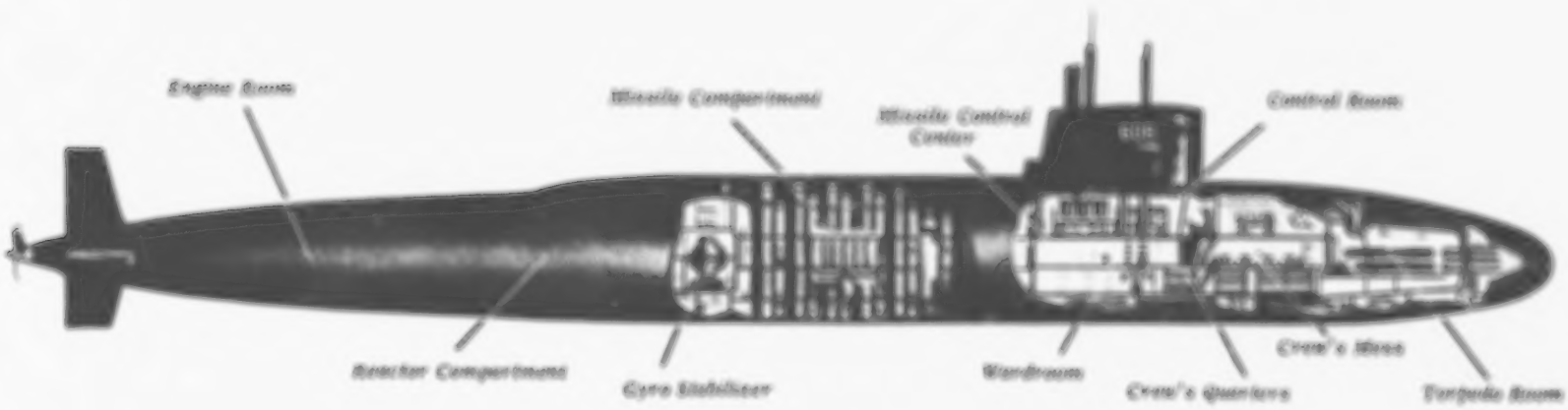
The U.S.S. Nautilus was the world's first nuclear-powered submarine. This picture shows the Nautilus cruising on the surface after launching on January 21, 1954.

U.S.S. ETHAN ALLEN

This nuclear submarine is one of the heaviest ever built. It is 410 feet long. The U.S.S. Ethan Allen can carry and fire Polaris missiles.

The drawing shows the locations of the compartments or rooms on the Ethan Allen. The reactor compartment contains the nuclear reactor. Energy for running the ship is obtained from this reactor. Uranium is used as a fuel.

Atomic fuel makes radiation. The crew of the nuclear submarine is protected from this radiation by the careful way that the ship was built. There is some radiation all around us, but the men on this ship usually receive less radiation than the average person does.



U.S.S. ETHAN ALLEN

U.S.S. SKIPJACK

This is the U.S.S. Skipjack. This submarine was the first of a new line of fighting ships. She has a blunt-nosed, football-shaped hull. The shape of her hull makes it possible for her nuclear power plant to give her the highest underwater speed of any submarine.

OTHER USES OF NUCLEAR POWER

Nuclear power is used for forms of transportation other than submarines. The "Savannah" is America's first atomic-powered merchantship. It can cruise 300,000 miles without refueling. There have also been experiments with atomic airplanes.

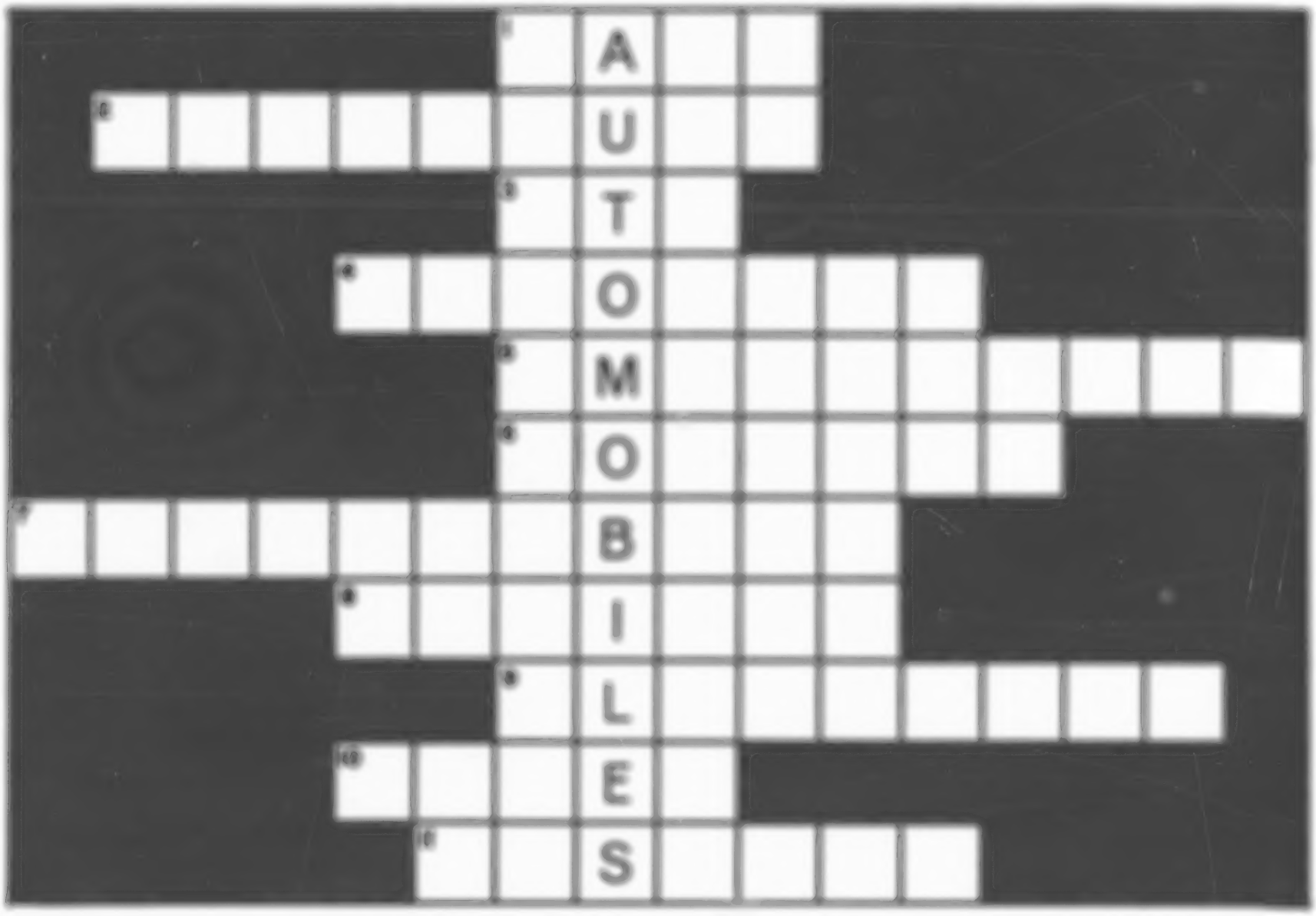
Atomic energy or nuclear power has many uses. The atomic bomb was made possible by the releasing of atomic energy. Nuclear radiation is used in industry, agriculture, and medicine. For example, radioactive iodine can be used to treat cancer.

N.S. SAVANNAH

NUCLEAR LIGHTHOUSE

A 4,600-pound atomic generator powered by radio-isotopes is lowered to the balcony of Baltimore Lighthouse, in Chesapeake Bay, to furnish power for continuous operation of the station's warning beacon. Baltimore Lighthouse, built in 1908, is the first lighthouse in the world to be operated by long-lasting atomic power.

PUZZLE 3. MODELS OF CARS

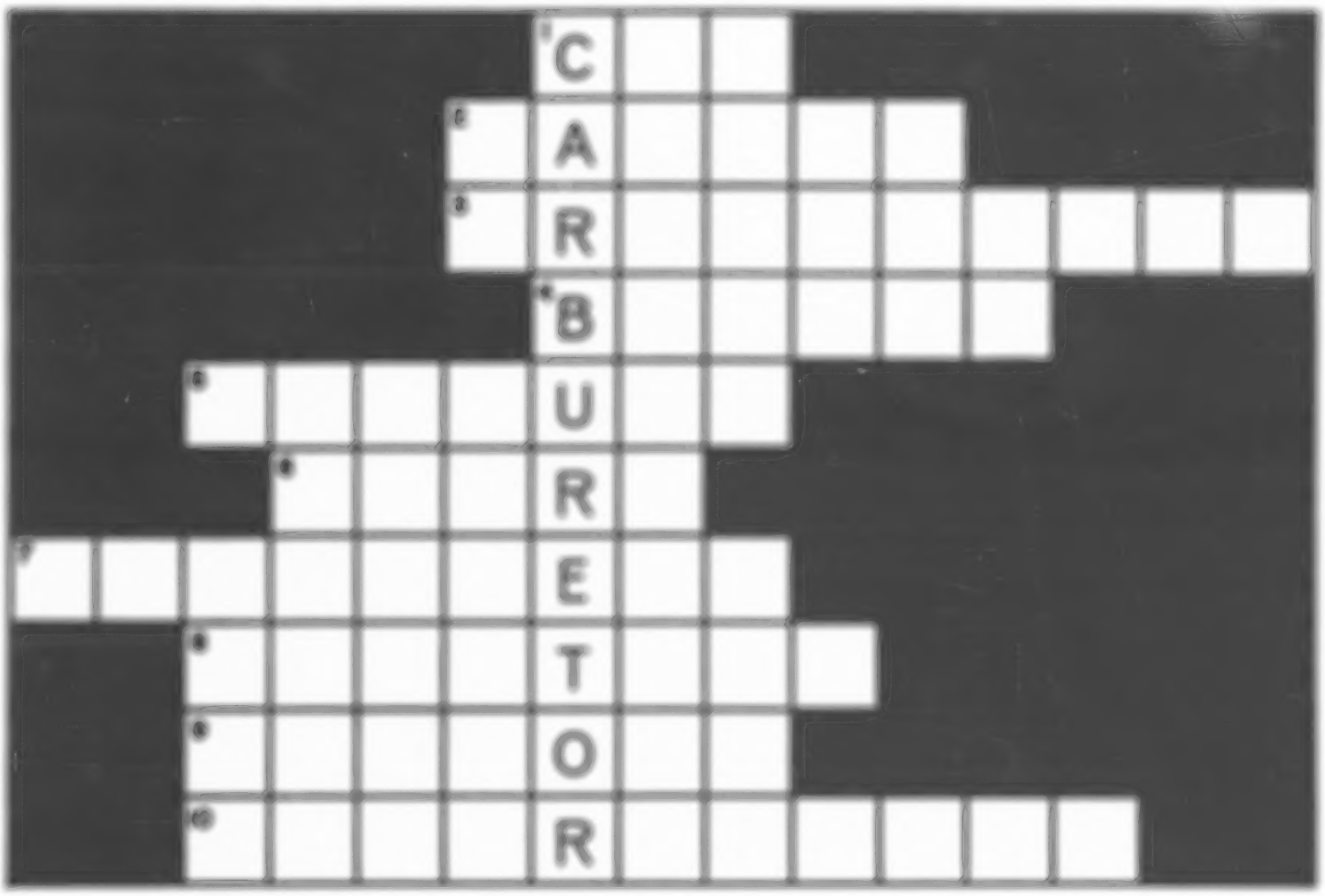


(Across only)

1. The Dodge Compact.
2. The Plymouth sports model.
3. The three letters for the new Pontiac (Gran Turismo Omologato).
4. The new Oldsmobile with front-wheel drive.
5. The largest Rambler model.
6. The Chevrolet Compact.
7. Ford's T-Bird.
8. One of Buick's luxury cars.
9. A well-known Cadillac model.
10. A Mercury Compact.
11. The new Ford Compact.

(Answer on page 119)

PUZZLE 4. CAR PARTS

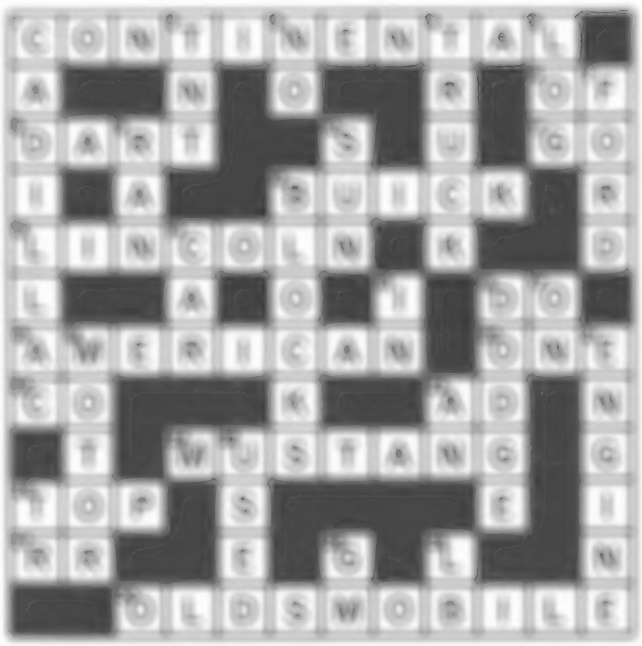


(Across only)

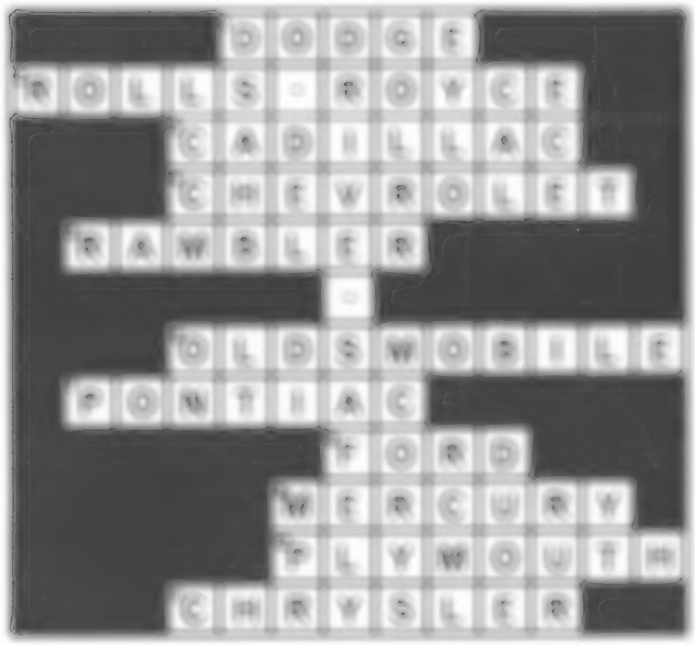
1. A part which rotates to open and close the valves.
2. They open and close to let the fuel-and-air mixture into the cylinders and the exhaust out.
3. All the connecting rods are attached to it to make it drive the power train.
4. You use these to stop the car or slow it down.
5. The burned fuel-and-air mixture which comes out of the tailpipe.
6. They are used for changing speeds.
7. A V-8 has eight of them.
8. The spark plugs are an essential part of this system.
9. They are inside the cylinders, are connected to the crankshaft, and are moved by the burning fuel-and-air mixture.
10. This is a device which sends electricity to each cylinder at the proper time.

(Answer on page 119)

ANSWER TO CROSSWORD PUZZLE NO. 1



ANSWER TO CROSSWORD PUZZLE NO. 2



ANSWER TO CROSSWORD PUZZLE NO. 3

ANSWER TO CROSSWORD PUZZLE NO. 4